SCIENTIFIC AMERICAN SUPPLEMENT. No 1066

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Scientific American Supplement, Vol. XLI. No. 1066.
Scientific American, established 1845.

NEW YORK, JUNE 6, 1896.

Scientific American Supplement. $5 a year.
Scientific American and Supplement, $7 a year.

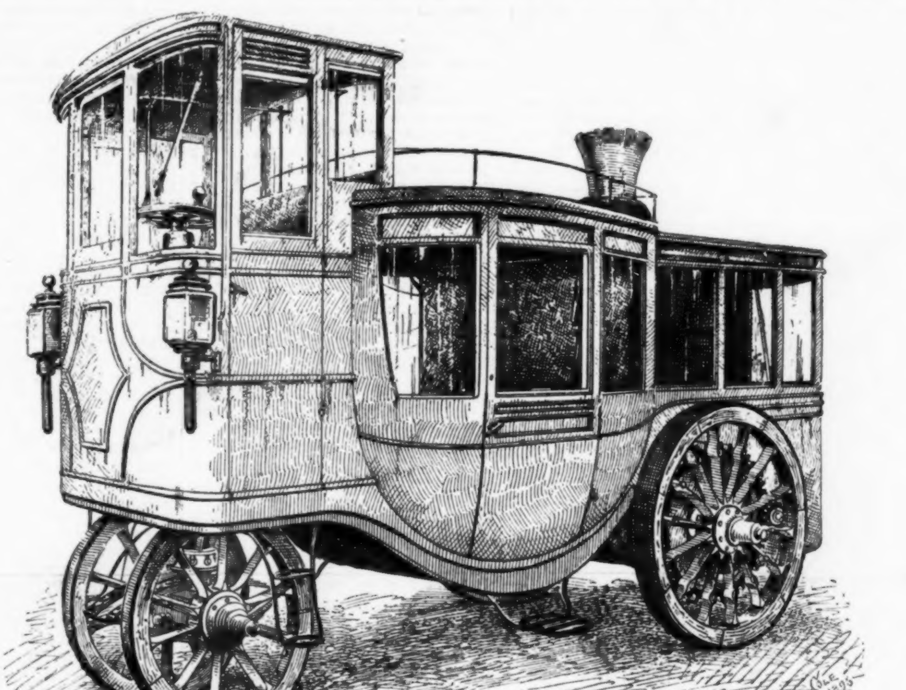
THE CRYSTAL PALACE EXHIBITION—RANDOLPH'S STEAM COACH.

WE illustrate this week from London Engineer one of the most interesting exhibits at the Crystal Palace. It is a steam coach built for Mr. Randolph, one of the partners in the celebrated firm of Randolph & Elder, of Glasgow. The coach is in a very dilapidated condition, unfortunately. For this, however, the South Kensington authorities are not to blame. The truth is that the coach is not old enough to possess value as a relic. It was in a sense a white elephant, as will be seen presently. It is very difficult to obtain any information concerning its career — probably because it had none. We are enabled through the courtesy of Gen. Festing and Mr. Last to reproduce the following extract from the Glasgow Herald of Wednesday, November 13, 1872, which will give an excellent idea of its construction. Our drawings have been made in the Palace by our special artist.

"We had yesterday an opportunity of inspecting a new steam carriage which appears to reduce the chances of accident to the lowest point, and entirely to remove the objection of disturbance to the general traffic of the street. The carriage to which we refer has been introduced by Mr. Charles Randolph, of this city, whose eminence as an engineer is a guarantee for the soundness of the principles which it embodies. Mr. Randolph has for a considerable time given careful attention to the subject of steam as applied to street locomotives, and his plans having been matured toward the close of last year, a carriage has since been constructed, and is now ready for use — the machinery having been made by Messrs. Dubs & Company, of the Glasgow Locomotive Works, and the carriage portion by Messrs. James Henderson & Company, of North Street, Anderston.

"The carriage is 15 feet in length, and is externally a handsome specimen of the coach builder's handicraft. It consists of three divisions or compartments, which are harmoniously united—the driver's box in front, the boiler and engine house in rear, with a compartment for passengers in the center—and is carried on four wheels, two at each end. Taking these compartments in the order thus indicated, we have first the driver's box, which is roofed and closed in with side and front windows, and is set on a higher elevation than the rest of the carriage. It is comfortably cushioned, and will accommodate two passengers besides the driver. Below this box is a "boot" in which luggage may be placed, or fuel stored for long journeys. Behind the driver's box, and on a lower level, so as to be easily entered from the street, is the central compartment, which will comfortably accommodate six passengers. It is lofty enough in the roof to admit of a person of average height standing with his hat on, and is fitted with spring cushions, an umbrella or parcel rail, and hat belts in the roof, while passengers may communicate with the driver by means of a bell which is conspicuously shown. In the engine house, which, as we have said, occupies the rear of the carriage, a seat is provided for the fireman, who takes his fuel from a coal bunk close at hand. The whole construction of the carriage is so designed as to secure order and neatness, together with the utmost possible economy of space in the working parts. When filled with passengers, and provided with water, etc., for a journey, its entire weight will be about 4½ tons. Passing from general details, we may now indicate the special engineering features of the carriage, in so far as these are capable of being explained to non-practical readers. Entering the driver's box, it will be seen that a lever is conveniently brought down on each side of the seat occupied by the driver from the roof. By drawing toward him the lever on the right hand, he applies brake power to both the sets of engines which drive the hind wheels, and may thus use it to stop the carriage on level ground, or regulate the restraining force of the drag, according to the steepness of the declivity down which the machine is traveling. With reference to the lever on the left hand, its purpose is to make the carriage run in either direction by acting upon the ordinary link motions, and its acting is so adjusted that its relative movements are the same as those which it is wished the carriage should perform—i. e., pushing forward for the carriage to go forward, and pulling backward for backing. This harmony of action renders thought on the part of the driver unnecessary, and obviates chances of error; and it will be apparent to those who understand the operation, that the greater the distance the handle is made to pass through, the greater will be the power of steam applied for propulsion. Rising through the center of the compartment is a pillar surmounted by a steering wheel placed in a horizontal position. This steering apparatus is, of course, directly connected with the wheels, but by an ingenious piece of mechanism, which need not be described, it does not partake of the jolting motion imparted to the wheels by the stones and other impedimenta of the streets. The carriage, too, is protected from the unpleasantness usually experienced in traveling along rough roads, but this we shall refer to in its proper connection. We have thus noticed the principal mechanical peculiarities of the driver's box, but there are also minuter, although hardly less important details to which we must advert. Thus, in front of the steering apparatus is placed a pointer, which unerringly indicates the position of the wheels relatively to the motion of the carriage. An important use of the pointer consists in the driver knowing before starting again the exact position of the wheels. A steam gage is also provided, whereby the steersman may at a glance ascertain the pressure of steam in the boiler; a mercury gage exhibiting the precise acclivity or declivity of the ground being passed over; and a mirror in front, showing the condition of the road or the traffic which may be coming on behind. The driver, again, is able to communicate with the stoker by pulling a bell, and the stoker may similarly arrest the attention of the steersman. For facility in steering, the two front wheels, which are 3 feet 4 inches in diameter and 2½ inches in breadth, are only 2 feet apart, while the hind wheels, which are 4 feet 6 inches in diameter and 4 inches in breadth, are 5 feet 4 inches apart, being the ordinary gage of an omnibus. The latter are each provided with a spur wheel, bolted on the side next the carriage, which is driven by a pinion upon the crank shaft of each of the pair of engines. The carriage is set upon springs of improved construction. In the case of ordinary vehicles, progress through uneven streets results in more or less jolting, even where all the latest improvements have been adopted, but the springs of Mr. Randolph's carriage are so nicely adjusted, and the weight of the machine itself is so great, that the jerking motion of the wheels is not communicated in any appreciable degree to the body of the vehicle.

"It now only remains for us briefly to notice the engines and boiler. There are two pairs of vertical engines, one on each side of the carriage, with 3 inch cylinders. The engines are quite apart from each other, so that, when a curve is being passed over, the



THE RANDOLPH STEAM COACH, 1872—THE CRYSTAL PALACE EXHIBITION.

engine and wheels on one side of the carriage accommodate themselves to the situation by acquiring increased velocity in proportion to the extent of the curve which is described. The carriage, we may add, can be readily turned in a street of ordinary width. As to the boiler, we notice that it is of the vertical type, and is fitted with Field's patent tubes, as also with a couple of safety valves, a water gage, gage cocks, and a pressure gage. The area of the fire grate is two square feet, and the heating surface is about 80 feet. The stoker is enabled to control the fire by means of a damper attached to the furnace, besides the ordinary method of working the furnace doors. The bursting strain of the boiler, assuming the material employed to be of only moderate quality, is 720 lb. on the square inch, but the metal used is of the very best description, and the boiler has been tested by the makers with 250 lb. of water pressure and 120 lb. of steam. It is not intended in practical working to exceed the 120 lb. With regard to the rate of travel, we may explain that when the pistons are running at the rate of 300 ft. per minute, the carriage will go eight miles an hour. Of course this is by no means a maximum velocity; downhill, and even on level ground, it may be exceeded, but in a general way eight miles an hour is the rate aimed at. The water necessary for supplying the boiler is contained in a tank capable of holding about eight hours' supply, and is conveyed from the tank by means of two Friedman's patent injectors. Besides serving this essential purpose, the water cistern, being interposed between the central compartment of the carriage and the boiler, tends to keep the former cool, and thus promote the comfort of the passengers. The waste steam from the safety valves, together with the eduction from the engines, pass into a single pipe, and are carried into a chamber surrounding the funnel on the top of the boiler. This chamber is so large in proportion to the quantity of escaping steam that pulsation is entirely avoided, and the pressure is reduced to equability. The steam is discharged from the chamber into the funnel in a thin annular stream, which surrounds the effluent gases rising from the fire beneath, thus acting as a blast, and obviating the sudden screech and snort which would otherwise prove an annoyance. No steam is allowed to escape in the boiler house, and almost none is seen to be emitted from the funnel. We may add that the first trial of the carriage took place a few mornings since, when it was under the guidance of Mr. Charles R. Harvey, who has throughout attended to the details of construction. The carriage was taken from North Street, Anderston, out to Parkhead, the result of this first run being in all respects satisfactory. Mr. Randolph, we understand, anticipates that the mode in which he applies steam power to his carriage may be adapted to tramway cars, omnibuses, lorries, and even to ordinary carts."

After the coach had made a few trips, there is reason to believe that the authorities prohibited its use in the streets, and we hear nothing more of it until 1878, when it was sent to the Paris Exhibition. We believe that its owner wished to sell it, or at all events to get orders for similar carriages for use in France or Germany. Failing in this, the coach was brought back to England, and presented as a gift to the patent commissioners. These gentlemen did not want it, and for some years it was stored under protest by the Patent Office authorities, who had no proper accommodation for it in the Brompton boilers. They told Mr. Randolph's representatives, we understand, that it must be broken up if not removed, and the reply was, "Break it up." This was not done, and more room became available when the museum crossed the road. The revival of locomotion by power on common roads lends the coach an importance which it never before possessed. It is a very ingenious vehicle, and contains not a little that is worthy of imitation. Notwithstanding its size, it was very light, weighing, we are told, only two and one-half tons empty, but its cost—£1,800—was very high.

[Continued from Supplement, No. 1065, page 17025.]

MACHINES FOR COMPOSING LETTER-PRESS PRINTING SURFACES.*

By John Southward.

I now leave machines for composing letterpress printing surfaces by setting up ordinary types, and pass on to that method in which types are entirely superseded. Realizing the difficulty of constructing an apparatus for setting up ordinary types, and seeing that attempts to deal with the problem of effecting economy by merely augmenting the rapidity with which types can be set up have been, more or less, failures from an economical point of view, successive inventors have, for many years past, been working in an altogether different direction. They have carried on a series of experiments with the view of ascertaining the practicability of providing other and quite different mechanical means to the same end. These experiments have only within the last few years led to anything which could be regarded as a practical invention. In the result, however, a most remarkable discovery has been made—that printing surfaces can be formed most rapidly and most cheaply, not by setting up types by a machine, but by composing instead, movable interchangeable matrices. These matrices have characters engraved upon them in intaglio, that is, hollowed out, and from them plates or bars for printing from are cast. The casts have the characters in relief, as in ordinary stereotypes.

The successive stages by which the new process was developed are three.

In the first matrix machines the plan attempted was to stamp letters, by means of separate punches, upon a soft, yielding material, like plaster or papier mache, and to take and cast from this by the stereotype process. An apparatus of this kind would resemble a typewriter, with a soft, impressionable material, such as what stereotypers call a "flong," to receive the separate impressions of the several letters. This method was found to be impracticable, for several reasons. In the first place, the casts from a matrix thus produced were not suitable for printing purposes, their surfaces lacking in that essential quality of perfect alignment, and absolute regularity and evenness. This was due to the thin dies making a deeper impression than the thick ones; hence the irregularity of the surface of the cast. This difficulty could not be surmounted, even if it were possible to get even surfaces by this method; it would be useless, because the lines could not be justified. The exact space which the letters of a line would occupy could not be conveniently estimated. Hence the lines were of irregular lengths, like those from a typewriting machine. A line thus formed was not adjustable to a given measure, after it was composed; the words could not be spaced out. Apart from these objections, the letter stamps rapidly wore out, and then a good cast could not be taken from them. The plan involved a double stereotyping process, if it were to be used for making the curved plates from which all largely circulated newspapers are printed.

The second stage was entered on when inventors began to set up whole lines of stamps, and impressed them all together upon the flong. This obviated the irregularity of surface arising from the unequal stamping of single letters. It was, however, open to several serious and, indeed, fatal objections. It involved the construction of a more complicated machine. A sufficient number of stamps had to be provided, so that, however frequently in one line a letter was required, there might be sufficient to meet the demand. The letter e might be wanted twenty or thirty times, and a corresponding number of dies had to be supplied. These had to be brought into line with great precision, and to be rearranged or distributed instantly. This involved the construction of a delicate and costly machine. No method was devised of using a dry matrix on which the impression could be made. The plan was most inconvenient, and the results very unsatisfactory; the objection arising from the double stereotyping remained. The dies also wore out very rapidly. It was, as I have said, a great advance upon the class of impression machines previously invented, especially in one way. The lines could be justified; extra space could be placed between the words, as formed by the dies, and the lines made of uniform length, after the letters of which they consisted were composed.

The third stage of invention was reached when, instead of type dies, movable matrices were composed—matrices adapted for transposition and rearrangement. When with them was combined a casting arrangement, whole lines, properly justified, could be produced in the shape of bars or lines, which corresponded, for printing purposes, to lines formed of movable type.

Three different machines on this principle have been invented and worked in America. Two of them, however, have been held to be infringements on the patents of the third. As they cannot be worked in this country, they have no practical interest for printers. The third, and the only workable one, is the apparatus known as the Linotype.

The original specification contains a clear statement of the nature of the invention. It related to a machine driven by power and controlled by finger keys adapted to produce printing forms or relief surfaces ready for immediate use, thus avoiding the usual operation of type-setting, and also the more recent plan of preparing by machinery matrices from which to cast the forms. By the use of the invention, it was stated, the operator is enabled to produce with great rapidity printing bars bearing in relief the selected characters in the sequence and arrangement on which they are to be printed. The machine embraces two leading groups of mechanism: first, those which form a temporary and changing matrix representing a number of words; and, second, those by which molten metal is delivered to the matrix and discharged therefrom in the form of printed bars. The essence of the invention was the changeable or convertible matrix. It was almost as great an improvement on the previous stamping devices as was the invention of movable types over that of engraving of pages of letters, which preceded typography.

I will not, however, trouble you with any further account of its mechanical details, and will refer only to its economical results as compared with those of type-setting machines as a class.

I will endeavor, with the utmost possible brevity, to explain the chief features of the invention. The Linotype machine comprises mechanism for—first, composing the matrices; second, casting from them when they complete a line of reading matter; third, distributing the matrices of which that line has been composed back again into their proper magazines, in order that they may again and again be used to form succeeding lines. Then these operations are carried on concurrently—that is to say, while the matrices for one line are being composed, the matrices of the previous line are being cast from, and at the same time the matrices for the line before that again are being distributed. The result is that lines of, as it were, stereotyped matter are produced.

The matrices are stored in the upper part of the machine in an inclined magazine with compartments, in which the matrices are assorted. As the magazine slopes, the matrices tend to slide downward by gravity out of this magazine.

In the lower part of the machine there is a keyboard and connected mechanism whereby, each time a key is depressed, a single matrix is permitted to fall out of the mouth of the magazine through vertical channels. The matrix then comes in contact with an inclined traveling belt, which carries it and succeeding matrices downward, one after another, into the assembling block, where they are composed or set up, side by side in a row.

After the line of matrices is thus composed, it is transferred to the cutting mechanism, by which the molten metal is injected into the incised letter of the matrices. The casting bar or mould provides for a bar being cast similar in height and body to a line of types. The bar is finished by knives, which shave off the feet and trim or plane the sides. One after another the line bars are sent into the receiver or galley, where they are made up into columns or pages, like lines of type matter, but with much greater facility than types, the lines being all in one piece.

The matrix is a piece of brass, 1¼ inch long by ⅜ inch wide. Its thickness is that of the letter or point to which it corresponds. The character it is to produce is punched on to the side, where there is a cavity in which the letter is engraved. At the upper end of each matrix are teeth, arranged in a peculiar order or number, according to the character. That is, a matrix bearing any particular letter differs as to the arrangement of its teeth from a matrix of any other letter.

These teeth are relied on as the means for effecting the distribution or re-assorting of the matrices. Above the open upper ends of the magazine channels is fixed a bar, which has longitudinal ribs on its lower edge. These ribs are adapted to engage the teeth of the matrices, and to hold them in suspension. The ribs of the distributing bar vary in conformation at different points in the length of the bar, there being a special arrangement over the mouth of each channel of the magazine. The matrices to be distributed are simply pushed forward horizontally upon the bar, so as to hang from it. Each matrix is thus suspended until it arrives over its proper channel, and on reaching this point the arrangement of the bar and the teeth permit the matrix to become disengaged, when it falls directly into the channel. Other matrices are meanwhile continuing their course along the bar to their proper points of disengagement. Thus the distribution is done entirely mechanically and automatically.

Justifying is done by what are called "space bars." They consist of two steel wedges, the thicker edges of which are in opposite directions. They slide upon each other, the planes of the outer edges being always parallel. The larger member is about 3½ inches long, and is tapered from about one-sixth of an inch at one end to a knife edge at the other. These spaces are inserted between the matrices of each word as set up, and the long tapered pieces can be pushed up from beneath afterward and so spread out the words, making the line of the required measure. This is effected merely by the operator touching a handle.

When the matrix system is adopted, the lines can be automatically justified. Means for mechanically justifying movable type have often been suggested and attempted, but in all instances without success. The distribution of the matrices, corresponding to the operation of distributing type, is also done mechanically and automatically. In the result, the lines are produced from six to ten times more rapidly than the most expert compositor could put together in his composing stick the types which would be necessary to form an equal quantity of reading matter.

This greatly increased output is obtained not merely by the increased speed at which matrices may be manipulated, but by the possibility of performing automatically, in one machine, the two subsidiary operations of justifying and distributing—the necessity for which, in hand work, so greatly diminishes the output of the compositor. I suppose it would be fair to say that the percentage of labor cost of the three operations in producing a piece of composition would be—setting the type, 70 per cent.; justifying, 10 per cent.; distributing, 20 per cent. By using matrices, the second and third processes are obviated, resulting in an economy of 30 per cent. This would be the saving if the speed were only that of hand composing. It is, as a matter of fact, much greater. As one compositor can easily produce 6,000 to 8,000 per hour, it is found that, when all incidental expenses are reckoned, the labor cost of composition is reduced from 40 to 60 per cent., according to management. It should be remembered, too, that as one operator does the work of 4 to 6 hand setters, the cost of composing room oversight is considerably simplified and cheapened by the reduction of the number of hands in proportion to the work done.

Within the last year or two improvements have been made which illustrate the capacity of the system. One of them is an arrangement whereby a given face can be cast on a variety of bodies. A nonpareil face may be produced on a minion body, or a minion face on a brevier body. By producing a shoulder on the line bars, "leading" a piece of matter is unnecessary. Thus, solid or leaded matter may be produced from one machine. The other improvement is an even more remarkable one. The machine may be adapted to produce any desired face, from ruby to small pica, by merely exchanging matrices. When it is required to change frequently and very quickly from one face and body to another, extra matrices, magazines, and moulds can be added, and the change can be made in from three to five minutes. One machine, therefore, may produce the different fonts used in a news office. It will also produce them in any quantities, provided it is supplied with sufficient metal—the cost of which is about 2d. or 2¼d. per lb.

I have time only to briefly mention two other advantages appertaining to the matrix system of line casting. When types are not used, there is a great saving in the cost of plant. The types produce only a certain superficial extent of matter according to their quantity; the matrices, supplied with metal, will produce an unlimited quantity of matter. Hence, men have not to stand still for want of type or sorts. When matter is required to be kept standing, if it is composed of type, there is involved the expense of keeping idle very costly material. If the matter consists of line bars, the idle material is only cheap metal. Work which requires frequent correction may be kept in the form of line bars, and thus tons, it may be, of valuable type can be liberated for other jobs. Stereotyping is unnecessary. It is resorted to merely to prevent the wear of type, or for the production of a new edition.

I will conclude by saying that an examination of the economic advantages of the two methods of mechanical composition—of that in which ordinary types are used and that in which movable matrices are used—must lead to a conclusion distictly favorable to the latter. Type-setting machines—if I may repeat what I have already mentioned—were introduced into the trade more than fifty years ago. Great inventiveness has been expended on their design, and much mechanical skill displayed in their construction. Immense sums have been sunk in producing them, and in bringing them before the notice of printers. Printers, on their part, have as a class shown no disinclination to adopting these machines, but, on the contrary, have in many instances expended large sums upon them. In not a few offices one invention after another has been tested for a time, and then abandoned, and the old system of hand composition resorted to. Notwithstanding these incontrovertible facts, we find that only in a small fraction of the number of printing offices now in existence is there to be found—after all these

* Paper read before the Society of Arts.

years of experience and trial—a type machine of any kind.

What do these facts point to? I believe that they confirm what I have already asserted, that the opinion held by the vast majority of printers is that type-setting of an ordinary kind can be, and is, as cheaply done by hand as by a type-setting machine—that it is only under conditions that may be regarded as peculiar and exceptional that such machines are worked to advantage.

I have mentioned the small number of type-setting machines at present used throughout the United Kingdom, and I have adduced the fact as evidence that machines of the type-setting class have not met the requirements of the printing trade. It is only right to apply the same test to the other and newer system. In doing so I find that although the Linotype machine has been introduced here for only five years, while type-setting machines have been tried for fifty years, there are far more of the Linotypes at work than of all the others put together. The machine is being produced at the rate of six to eight per week. There is another significant fact. There are now hardly a dozen newspaper offices in England in which machines other than Linotypes are used—and in most cases, these type-setting machines were put in before the Linotype was perfected. Some of the leading newspapers have altogether discarded type-setting machines. The rapidity with which the improved system of mechanical composition is coming into general use is most remarkable, especially when we remember that composing machines of any kind have been so much disparaged and brought into disrepute by the failures of the type-setting appliances during the past half-century. The demand for these Linotype machines also confirms what I have said as to the readiness of printers to adopt machinery, provided only that it can be shown to be profitable.

If I am right in the conclusions I have ventured to lay before you, I am justified in believing that during the latter years of the nineteenth century the possibility and the advantage have been proved of a complete revolution in an art which, in so far as it depends upon the use of types, has remained stationary for more than four hundred years. The economic importance of this fact, and the far-reaching influence it must exert on the business of printing in the immediate future, must be my apology for bringing before the members of the Society of Arts this necessarily brief and superficial, although I hope fair and unbiased, comparison of the leading principles of machines for composing letterpress printing surfaces.—Journal of the Society of Arts.

COMPOUND MARINE BOILERS.*

By Col. N. SOLIANI, Director of Naval Construction, Royal Italian Navy; Member.

THE steady advance of water tube boilers in the field of steam navigation has aroused a natural reaction in favor of ordinary marine cylindrical boilers, which, according to many, although inferior in certain respects, possess features of great value for marine purposes, not yet fully secured in the new boilers. This view refers, however, to boilers for ships other than torpedo craft, which have requirements that only water tube boilers can now fulfill. Within these limits the contention in favor of cylindrical boilers does not appear groundless.

In fact the marine cylindrical boiler is not a new production of the inventive genius of man, but is the result of experience of two generations at sea. It is the last stage reached of development and improvement, under existing practical conditions, of an "organ" in the evolution of the entire "organism," "the steamship," to which it belongs. And, in such a long adaptation to surrounding conditions, the marine boiler, from the early types to the present one, has, in effect, developed features of real fitness for ocean navigation, and reached a state of perfection not easy to attain immediately with any new boiler.

The prominent features of the modern marine cylindrical boilers are well known, viz., efficiency, simplicity of parts, fewness of bolted joints, durability, easiness of inside inspection, fitness to available space on board ships, small liability to derangement, possible concentration of large power in few boilers, so reducing number and complication of pipes and fittings, steadiness of action, by which water feed and steam pressure are under easy control, facility of repair of the heating tubes under steam, adaptability for temporary use of sea water for supplementary feed, etc.

Although some of the foregoing characteristics may be claimed also for water tube boilers of various types, others of them are certainly special to the cylindrical boiler, and it is to these important features that cylindrical boilers owe their success in the domain of ocean navigation and the present campaign in their favor.

In this respect it is worth notice that, if we except France, where water tube boilers of the Belleville and a few other types are in general use both for merchant and war ships, in England and other countries the mercantile marine has not yet shown any marked propensity to abandon its familiar and faithful servant; while the navies, although now in full swing for the new boilers, began really to feel the want of a change only when the cylindrical boilers "appeared" unsuitable to forced draught. I use on purpose the word "appeared," because I think it is not yet proved whether the proclaimed unsuitableness is unavoidably due to organic constitution of the boilers or to the magnitude of the extra strain and suddenness with which it was applied before the boilers were given time to adapt themselves to the new demands made upon them.

In support of this view, the very good results obtained with the Serve tubes and with the Howden and Brown systems of conbustion, by which the steaming power of marine cylindrical boilers, per unit area of wetted heating surface, has been brought up to the limits which were lately deemed dangerous, might be mentioned; but, apart from these arrangements, which if efficient in increasing the specific power of the boilers, have certainly not improved them in respect of lightness and suitableness to rapid steaming—which are prominent features of the water tube boilers—it may be asked: Have cylindrical boilers reached their last stage of development? Cannot such boilers compete much longer, or must they soon give way to the new comers?

Well, while it is pretty certain that, owing to certain important advantages which water tube boilers offer, principally for navy purposes, the difficulties which still beset their general adoption will be vigorously attacked and finally overcome, I think, from what has been said above, that cylindrical boilers not only have, as yet, a great power of endurance in the mercantile competition, but that there is still room on their side for further improvement, by which their vitality may be increased and the struggle prolonged, even for navy purposes, with advantage to the great interests involved.

This new vitality may, I think, be conferred on cylindrical boilers by "compounding" them with water tubes in such a way as to make them partake, to a certain extent, of the good features of the water tube boilers, without detracting much from their own valuable characteristics.

There are already in the market various compound boilers—viz., boilers having the heating surface made up both of water and fire tubes.

Such are the Roger's boiler, the Barthlet's boiler, the Anderson and Lyall's boiler, etc., but none of them, as far as I know, may be styled "a real compound marine cylindrical boiler." Even the Anderson and Lyall's boiler, although more akin to it, is altogether a different thing; it is a special boiler of itself, having features which belong to various types, resembling a locomotive boiler in its furnace, a marine boiler in its combustion chamber, and a stationary boiler in its barrel.

In saying so I do not wish to disparage these boilers, which, on the contrary, appear very good and efficient, but simply to show that they are not the kind of boiler I mean—viz., a marine cylindrical boiler compounded with water tubes to the extent that is necessary to give protection to the tubes and tubeplates, and improve the boiler also in other respects (such as economy of weight, fitness to rapid changes of temperature, etc.), but without altering its main characters.

Such a result may, in my opinion, be achieved simply by doing away altogether with the water spaces around the ordinary combustion chambers, and substituting for them water tubes, some of which would be properly arranged as a protecting screen in front of the tubes and tubeplates.

My meaning will perhaps be clearer by reference to Figs. 1 to 4, in which the proposed alteration is sketched as applied both to single and double ended cylindrical boilers.

Such boilers, if successful, would be lighter simpler, less sensitive to difference of temperature and to rapid changes of fire; while the screen of water tubes in front of the tubeplates would in them, as in the Anderson and Lyall boiler, protect to a great extent plates and tubes from damage under forced draught.

In other words, these boilers would fulfill most of the requirements of modern steaming at sea, and exert, if adopted, a useful function in the present period of transition, which, by them, would become longer and smoother.

The benefit would be mainly felt by the mercantile marine, on account of the larger interests involved, and because of its requirements, to which the ordinary marine boilers appear on the whole so well suited.

Another advantage of the arrangement I propose would be the facility of admitting air under the back end of the firegrate, in a proper measure, to improve the efficiency of combustion, through a regulating door fitted under the bridge and underneath the casing of water tubes forming the combustion chambers.

In marine engineering I am only a dilettante, therefore, in what I have had the honor to say, my aim has been simply to raise a question which seems important and to elicit discussion by the experienced members of the institution. My suggestions may be briefly summarized as follows, with a view to meet discussion:

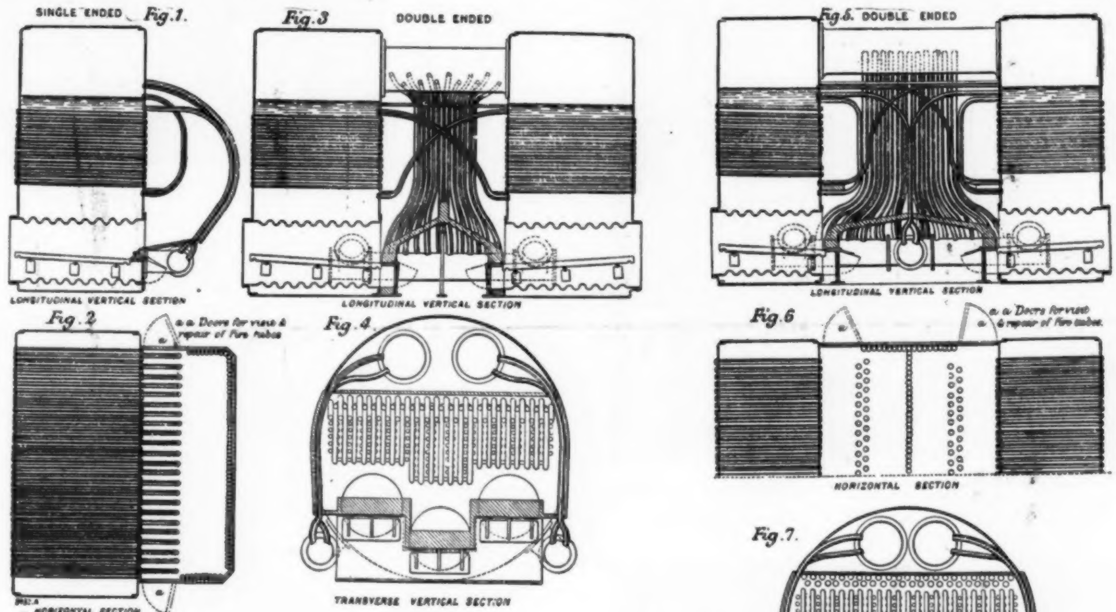
1. For swift vessels of small dimensions, designed for the use of torpedoes or special services, water tube boilers are a necessity.

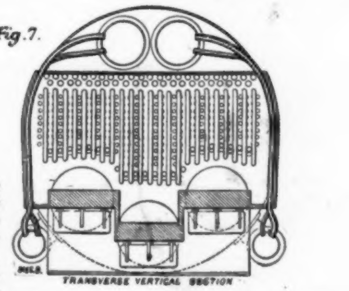
2. For certain classes of warships of larger size water tube boilers are distinctly advantageous.

3. For mercantile purposes and many classes of warships the water tube boilers are not yet perfectly suitable, and the cylindrical type of marine boiler is still to be preferred, and its continued employment is probable for some considerable time.

4. There is a possibility of retaining the most valuable characteristics of the cylindrical type, while securing increased efficiency and fitness to meet the exigencies of modern steaming, by means of arrangements of water tubes somewhat of the character illustrated by Figs. 1 to 7.

* Paper read before the Institution of Naval Architects.





COMPOUND MARINE BOILERS.

AN OLD NEWCOMEN STEAM ENGINE.

LAST year we gave a description of a Newcomen engine set up by the inventor in the valley of Fairbottom, midway between Ashton-under-Lyne and Oldham (Lancashire). This old relic of the last century was in a complete state of dilapidation. Exposed to all the inclemencies of the weather and abandoned by its owners, the legatees of the earldom of Stamfort and Warrington, it must now be lying upon the ground and in a state of scattered ruins.

More fortunate is the engine of the same type installed at the coal mine belonging to the Ashton Vale Iron Company, of Bedminster, and designed, like the preceding, for the drainage of the water of subterranean galleries. The pit, called South Liberty, which it dries at a depth of about 750 feet, is situated at three miles from Bristol. It was sunk 150 years ago, and the engine, probably being of the same age, thus dates back to 1745. The mine is still worked and annually furnishes a certain quantity of coal. The engine runs five hours a day and six days in a week. It is very probable that it is the oldest drainage engine that is now in regular operation.

We borrow the description of this curious apparatus from an article published in Engineering by Mr. Bryan Donkin, who discovered it and has given various sketches of it. Fig. 1 gives a general view of the installation and Figs. 2 and 3 show the details of the walking beam reproduced from photographs.

It will be remembered that the Newcomen steam engine is merely a simple acting machine in which the action of the steam is limited to the balancing of the atmospheric pressure during the first part of the stroke of the piston. After the latter has reached the

top of its stroke, there is sent under it a certain quantity of cold water, which condenses the steam. The excess of the atmospheric over the remanent pressure then causes the piston to descend. The rod of this latter is connected with the extremity of a walking beam which, at its other end, actuates the pump rods, so that, during the ascent of the piston, these rods reach the end of their travel, and rise at the time of its descent.

The engine in question was formerly supplied by two generators called haystack boilers, on account of their form, and which it became necessary to condemn thirty years ago. Since then, other generators have been employed, which are placed in the vicinity, but which it is not thought prudent to put under a pressure of more than 2½ pounds, on account of the age of the motor. The cylinder of the latter is 5½ feet in diameter and of 6 foot stroke. It is of iron cast in a single piece and with a conical bottom designed to exhaust

troduction of steam. The second, B, is a slide valve for injecting water to condense the steam. The third, C, is a flap valve for the escape of the water of condensation. The first two are maneuvered automatically by means of small walking beams actuated by levers and rods from the main beam.

The pump rods are, as we have said, three in number. The first pump is placed at the bottom of the pit and discharges into the second, arranged near the center, and this into the third, which lifts the water to the surface. They are all 9¾ inches in diameter. The feed pump of the injection water reservoir is situated in the engine room and is actuated by a chain coming from the walking beam and passing over guide pulleys to reach the simple acting piston.

The engine makes ten or eleven strokes a minute. It works with several inches of water at the top of the piston, so that in case of leakage, at the time of condensation, such water descends under the piston and

tact after an operation of a century and a half.—Nature.

ECONOMY OF MECHANICAL TRACTION FOR STREET RAILWAYS.

A good illustration of the large saving effected by mechanical traction as compared with horse traction on street railroads is given in a recent report made by President Vreeland of the Metropolitan Traction Company, New York City. In this report he states that the company now have 164 miles of single track, of which 25·34 are operated by cable, 6·78 miles by the underground electric trolley system, and 131·88 miles by horses. The net earnings of the one-fifth of the mileage which is operated by cable and electric traction were so large in 1895 as to carry the entire investment. Mr. Vreeland observes that it is not only through an increase of business that this was brought about, but

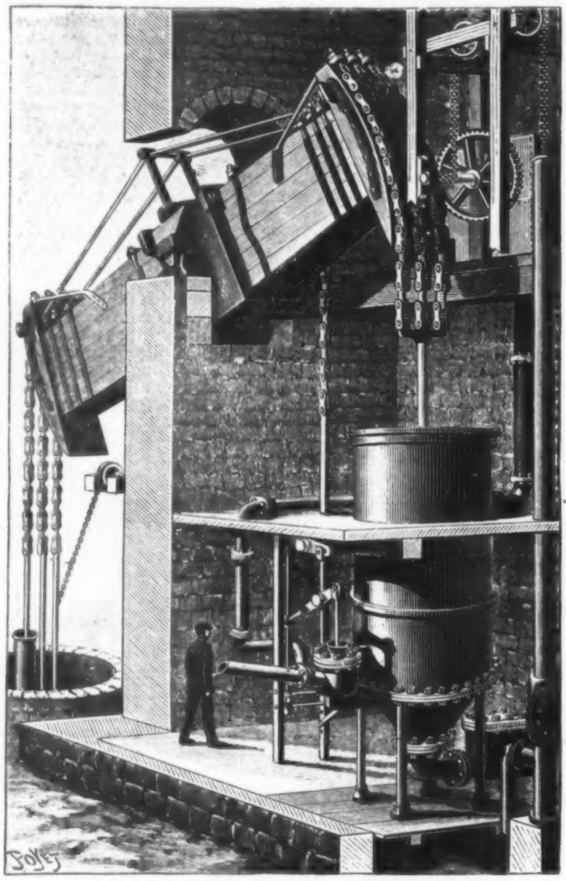


Fig. 1.—ANCIENT NEWCOMEN STEAM ENGINE NOW IN OPERATION NEAR BRISTOL, ENGLAND.

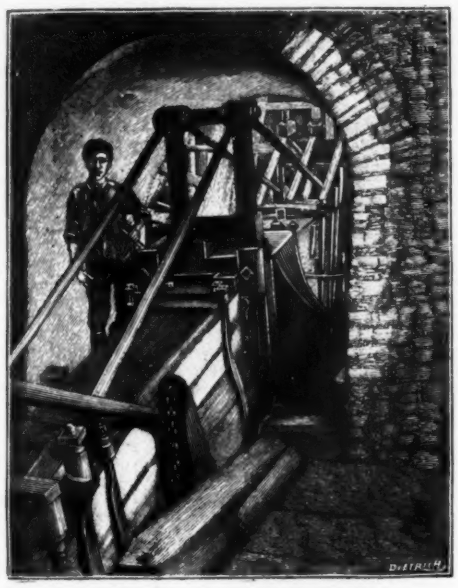


Fig. 2.—VIEW OF THE WALKING BEAM.

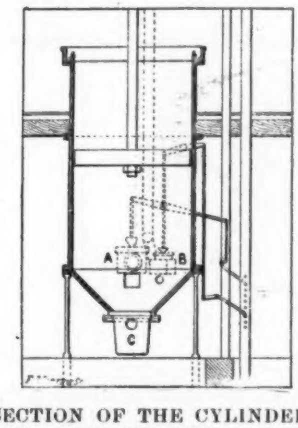


Fig. 4.—SECTION OF THE CYLINDER, SHOWING THE ARRANGEMENT OF THE DISTRIBUTING VALVES.

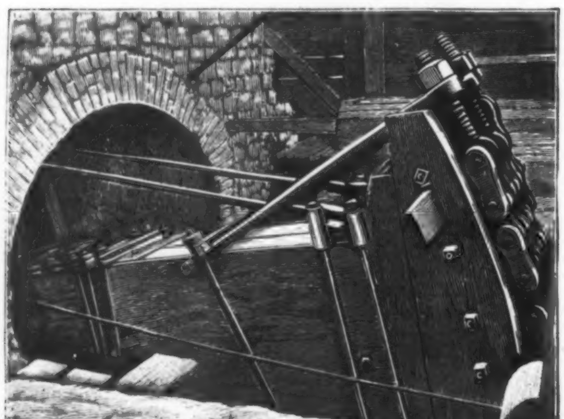


Fig. 3.—VIEW OF THE LEFT END OF THE BEAM, WITH PUMP CHAIN CONNECTIONS.

Fig. 5.—INDICATOR DIAGRAM.

the water of condensation. The whole weighs about six tons. The piston actuates a walking beam, 24 feet in length and 4 in depth, built up of a certain number of oak beams trussed together. It weighs, with iron work, trusses, gudgeons, etc., five tons.

At each end of the beam there are arranged wooden arcs of circles upon which, on one side, work the chain that carries the rod of the steam piston and that which maneuvers the jack water pump situated to the left of the cylinder (Fig. 1), and, on the other, the chains that support the rods of the three pumps. Fig. 2 gives a view of the left side of the walking beam and Fig. 3 a general view of the same part of the engine. The man figured here is the mechanician whose business it is to watch over the operation of the engine. His father and grandfather performed the same duty before him, and he told Mr. Donkin that he began so young that he was obliged to stand on a block of wood in order to reach and maneuver the valve handles.

The distribution is effected by means of three valves placed very near the bottom of the cylinder. The first of these (Fig. 4) is circular, and serves for the in-

contributes toward maintaining a vacuum by preventing re-entrances of air.

No indicator diagram had ever been taken from the engine, but one was obtained by Mr. Donkin especially to illustrate his notes. To this effect, the cylinder had to be drilled and gear fitted. The diagram was taken under great difficulty and amid a cloud of steam and coal dust. The power of this diagram, taking ten strokes a minute, works out at about 52¾ indicated horse power—a very small power, considering the weight and size of the engine, compared with present practice. Mr. Donkin does not state the amount of water lifted.

The days of the engine of the South Liberty pit are doubtless numbered, and it is hoped that the venerable relic may find a last resting place in South Kensington Museum among so many other remarkable engineering antiquities. While awaiting this merited repose it is daily performing its function with a curious creaking noise of the walking beam at every stroke of the piston—an interesting example of one of the first drainage installations that has remained nearly in-

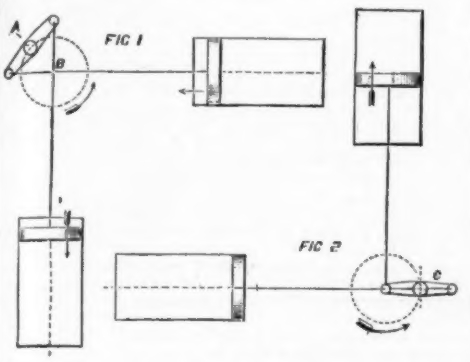
mainly through economy in operation. When the entire traction system was operated with horses, the cost of operation was 70 per cent. of the gross receipts. The substitution of mechanical traction on twenty miles out of 122 reduced the cost of operation of the entire system to 54·39 per cent. The cost of operating the Broadway line alone was reduced from 66 to 38 per cent. by the change from horses to cable traction. These figures indicate plainly the great diminution in cost which will accrue to the Metropolitan Traction Company when the entire system is equipped for mechanical traction.

In a London theater a play is now running which requires singing by a choir and cheering by a crowd, says the Electrical Review. The choir and the crowd are placed in rooms behind the scenes. Both these rooms are provided with a set of colored incandescent lamps. The lights are turned on and off from the prompter's box, and serve as signals for the cues. One color is to get ready, another to begin, another to increase the sound, and so on.

THE LINK MOVEMENT ENGINE.

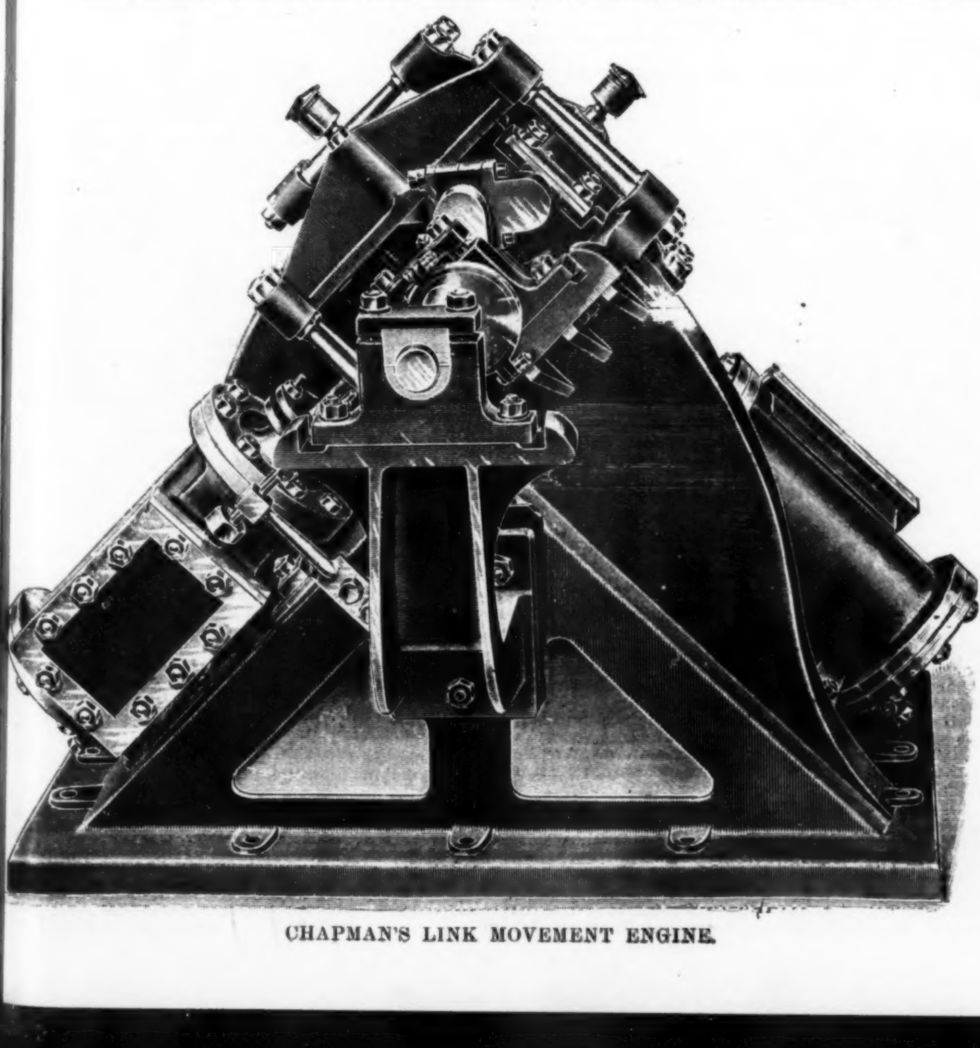
WE reproduce from the London Engineer a curious engine patented by Mr. G. Chapman, and constructed by Messrs. John Milne & Sons, Milton House Works, Edinburgh. The object of the inventor has been to produce an exceedingly compact engine, and a glance at the engraving will show that he has accomplished his purpose. There are no connecting rods. Roughly speaking, the two pistons move diagonally, and cross and recross midway at every stroke, a link, half the length of each, connecting them; a pin at each end of the link passing through the crossheads forms the respective cranks, and circular motions cause the rotation of the shafts, the pressure on the slippers being reduced to a minimum.

It is a known geometrical fact that any point in the



circumference of a circle revolving on the inside of another of double the diameter will describe a straight line. Mr. Chapman's engine utilizes this principle in a way that will be readily understood by the aid of the two small diagrams annexed. Fig. 1 shows the pistons at the ends of their strokes and Fig. 2 shows one at half stroke. The crank length is from A to B, or half the diameter of the virtual circle within which the crank pins revolve. Any of our readers accustomed to geometrical work will see that this is an extremely pretty parallel motion without further description. The details of the engine have been very neatly worked out. It is not possible to dispense with guides, because the pressure on the pistons varies. But Messrs. Milne say that a new engine which they have tested gave about 78 per cent. of its indicated power on the brake at 180 revolutions per minute. This, for a small engine, with cylinders only 5 in. diameter by 10 in. stroke, is very good work.

The cranks are side by side, the flying crank, C, Fig. 2, acting like an ordinary drag link. This seems to us to be a very meritorious attempt to solve a difficult problem.



CHAPMAN'S LINK MOVEMENT ENGINE.

HONIGMANN'S METHOD OF BORING MINE SHAFTS.

IN a communication to the ninth international meeting of boring specialists at Halle-an-der-Saale, as to the latest improvements in deep boring and shaft boring, Oberbergrath Tecklenburg observed that Herr Honigmann, of Aachen, had carried out several sinkings by a method, similar to one proposed by himself, which consists of letting down a sinking tower into a tubbed shaft, and pumping out from the former water mixed with loam or clay, that is allowed to flow back into the shaft, the loam addition consolidating the shaft sides. In a communication to Gluckauf of November 2, 1895, Herr W. Schulz, taking exception to the above observations, gives a detailed description of the Honigmann method of shaft boring, the great technical advantage of which, he says, must be apparent to everyone engaged in boring, while it effects a considerable saving as compared with other methods for sinking shafts in recent measures. Indeed, he considers that it may perhaps be the means of bringing about earlier extraction of the considerable coal wealth underlying thick recent deposits.

The method was applied, states Herr Schulz in Colliery Guardian, to two shafts put down in the Oranje-Nassau coal concession near Heerlen, in Holland. Of these, one shaft, 2·8 m. (9 ft.) diameter in the clear and 68 m. (37 fathoms) deep, was bored down to the compact marl; and the other, 40 m. (43 yards) distant, had attained a depth of 45 m. (24½ fathoms) when visited by the author. The borehole put down in advance showed the following section of strata:

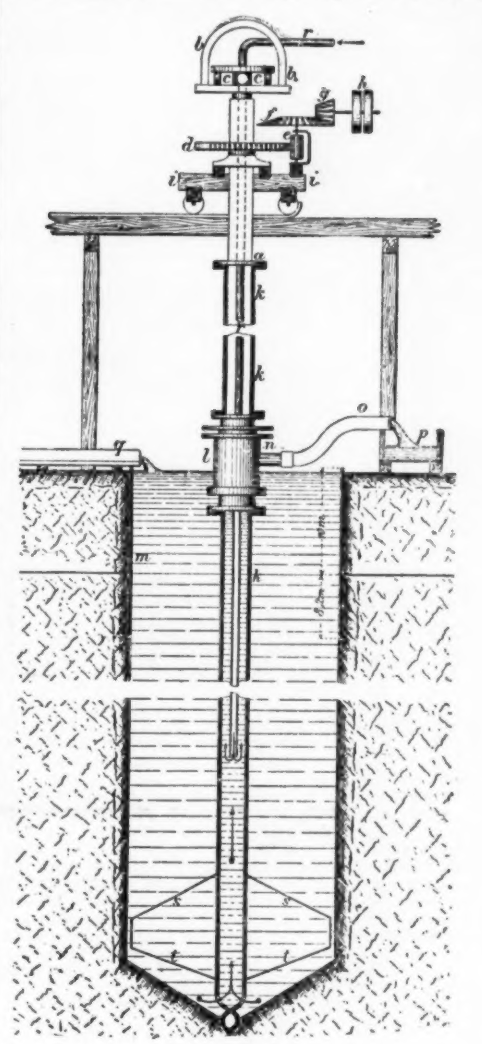
	Meters.
Loam	9
Loam with sand	2
Sand with pyrites	1·38
Sandy clay	0·18
Grayish white sand	8·94
Greenish clayey sand	5·18
Lignite	0·75
Black clay	0·35
Greenish-gray rich clay	2·87
Brownish sand	2·5
Gray sand	0·53
Greenish-gray sand with mica scales	9·5
Loose sand	0 3
Compact greenish sand	2·7
Compact greenish clayey sand	10·82
Greenish clay	1
Greenish clayey sand	9·58
	67·58

Alternately hard and clayey marl containing lime, 14·58 m.

The Honigmann method, which was employed for both shafts, is described in the following terms: In the first place a sinking tower (Senkschacht) 3·8 m. (12 ft.) in inside diameter, built up wrought iron plates 15 mm. ($\frac{19}{32}$ in.) thick, was let down to 18·2 m. (19 yards) below the surface, so that its lower edge was about 8 m. (8¾ yards) below the natural water level, after which began the boring proper. The boring tool consists of a channel-iron frame (see accompanying figure), the lower cross-piece of which and its sides carry changeable steel cutters on their under side. The central shank of the boring tool is a cast-iron pipe of 135 mm. ($5\frac{5}{16}$ in.) inside diameter, with a thickness of 25 mm. (1 in.) and open below, which is fastened to the hollow wrought iron rods by means of flanges. The principal or usual pipes composing this rod are 4 m. (13 ft.) long, while the additional pipes are 1 m. and 2 m. long, of the same internal diameter and 8 mm. ($\frac{5}{16}$ in.) thick, the pipe lengths being coupled by flange joints. The wrought iron flanges are connected together by four bolts of 30 mm. ($1\frac{3}{16}$ in.) diameter.

For causing the rod to revolve, the boring tower contains an arrangement similar to that used for large boring tools driven by belt from a portable engine; but the most essential points of difference between this arrangement and that for large boreholes is that (1) the borings are pumped out continuously through the hollow rod; (2) a constant stream of water mixed with clay is allowed to flow into the sinking tower, and consequently also into the shaft to be bored; (3) an excess of pressure in the water filling the shaft to be bored over that from the measures inward is set up; and (4) the sides of the shaft to be bored need not be lined until the solid rock is reached.

By setting up an excess of pressure in the shaft, opposing the inward pressure, all falling in of the sides is prevented; and in sandy strata the sand is consolidated by the clay that is mixed with the water. Now, this excess of pressure is brought about, first by the fact that, in the shaft to be bored and in the sinking tower, water is always introduced, the level of which is maintained, in the present case, at 10 m (32 ft.) above the natural water level; but secondly, the excess of pressure is further increased by the fact that this water is mixed with clay. The specific gravity of the water filling the shaft is brought up to 1·2; and on



that account the pressure against the shaft sides amounts to 2 kilogs. per square centimeter (28 lb. per square inch) at a depth of 50 m. (27 fathoms).

The water containing the mud from boring, pumped out from the hollow rods, is led into a series of timber tanks, in which most of the debris is deposited, when the water runs back into the shaft by a channel; but, if it has not a sufficient proportion of clay, this substance is added until the specific gravity attains 1·2. Inasmuch as a portion of the water filling the shaft percolates into the sides, when they consist of sandy strata, and is therefore not pumped out with the borings, this deficiency must be made good.

For pumping out the borings, a small duplex steam pump is employed, the suction pipe of which is put in communication with the outlet nozzle of a revolving head (see figure) so that it can readily be disconnected. This revolving head is inserted in the series of hollow rods, slightly below the upper edge of the sinking tower, in such a manner that the water drawn from the lowest length of the rods rises to the revolving head, and is drawn by the pump out of the nozzle inserted in the side of the head, through the above-named Indiarubber pipe, which pump forces it into the tank for depositing the borings. The pipe is long enough to follow the boring rods in their descent until a new length is inserted. If all goes well, a depth of 2 m. (6 ft. 7 in.) can be bored by this method in a twelve-hour shift.

Shaft No. 1 at Heerlen was bored by this method without the sides having fallen in; and then the iron tubbing was inserted so as to rest upon the marl. In shaft No. 2 a similar tubbing of 3·36 m. (11 ft.) inside diameter will be put in so soon as the marl is reached. The rings composing the tubbing are made up of three plates of 20 to 30 millimeters (mean 1 in.) thickness. On the inside of the vertical joints, flat strips, 20 cm. (8 in.) wide and 20 mm. ($\frac{13}{16}$ in.) thick, of iron plate are riveted. The rings, which are 2 m. (6 ft. 7 in.) high, are further strengthened inside by three to four riveted iron bar rings, of the same width and thickness as the strips above mentioned, and evenly spaced out. The lowest ring of the tubbing is provided with a sharp edge; and the connection between the individual rings of the shaft lining is effected by cylindrical plate iron rings 20 cm. (8 in.) high and 20 mm. ($\frac{13}{16}$ in.) thick, riveted inside. As in the Kind Chaudron method, the tubbing is allowed to float, the water ballast being let out through the balance pipe; but no anchor need be employed for suspending the tubbing—care, however, being taken to guard the latter from sudden descent by

means of fagots. The outer diameter of the tubbing is 400 mm. (15 in.) less than the inside diameter of the bored shaft, so that there is a space of 200 mm. (8 in.) between the two, which is afterward filled with concrete.

In a further communication to Gluckauf of April 4, Herr Schulz states that in October last No. 2 of the Heerlen shafts had attained a depth of about 45 m. (24½ fathoms) while 26·8 m. (14½ fathoms) remained unsupported by any lining, its present depth being 53 m. (29 fathoms). The reason that greater progress has not been made is that one of the boring rods broke, its extraction causing considerable delay; and the author observes that further proof of the practicability of the Honigmann method is afforded by the fact that the shaft sustained no damage during the operations necessary for securing the broken rod. During this work the unlined sides of the shaft were, of course, always subjected to the pressure of the water mixed with clay constantly running in, so as to make up for that flowing away into the sandy strata, and keep the shaft full.

The accompanying vertical section is rather a diagram for demonstrating the principle than a scale drawing; and the arrangements adopted are only so far represented as to show clearly the turning of the bore-rod and the manner in which the borings are taken off. The iron boring spindle, a, of square section, is so hung in the crown, b, that the friction caused by its rotary motion is reduced to a minumum by the anti-friction rollers, c c, these latter taking the place of balls which have been used for the same purpose in other cases. The crown is suspended by a wire rope which is wound up and unwound round the barrel of a hand-winch, just so much rope being given as is required for the advance made. The boring spindle passes through the spur-wheel, d, which is driven by the spur-pinion, e, and the bevel gear, f and g, the latter of which takes its motion from the fast pulley, h, by a belt from a portable engine. The driving gear, d, e, f, is carried by the truck, i, which can be drawn on one side by a steam winch when it is required to bring up the bore-rods. The boring spindle, a, carries the hollow part, k, in which the turning head, l, is intercalated; and the boring tool is shown by s, t, no other working parts, however, being represented. The lining of strong riveted plates, carried down to a depth of 18·2 m. (10 fathoms), is shown by m; and its lower edge is 8 m. (26 ft.) under the natural water level.

In the present sinking, instead of the borings (whose direction is shown in the section by arrows) being pumped out through the turning head, Herr Honigmann adopts the method already employed by Werner Siemens in 1885, viz., that of introducing compressed air into the hollow rods, by means of which the weight of the column of borings in the hollow rod is reduced, while they are lifted to the turning head by the pressure of the water that fills the shaft, and are discharged from its nozzle, n, and pipe, o, into the channel, p. Through the channel, q, flows regularly the water mixed with clay that fills the shaft, maintaining the water level therein.

For leading the compressed air into the hollow rods a common gas pipe (shown by r in the section), of 25 mm. (1 in.) inside diameter, is employed. As the water charged with clay filling the shaft has a specific weight of 1·2, it exerts a pressure of 6·36 atmospheres underneath the column of borings in the hollow rods, so that their specific weight must be brought below 1·2 for being raised by the water which fills the shaft.

As working parts to the boring tool Herr Honigmann now employs rollers provided with disk-shaped cutters, which are fitted to the portions marked t t of the boring tool in such a manner that their center lines are parallel with arc chords of the shaft's circle. The form of the cutting parts was determined by the compact cretaceous marl that was thought to exist below.

The reason why the sides of a shaft in shifting measures are prevented from falling in by the Honigmann method is that an outward current is set up by the excess of pressure exerted by the water filling the shaft; and the speed of this current is in direct proportion to the speed, v, which is capable of maintaining substances in suspension. This speed for substances of irregular form is, according to Rittinger—

$$v = 2{\cdot}44\sqrt{d\,(\delta - 1)}$$

d being the diameter of the substances and δ their specific weight. From this speed thus calculated the necessary height of the water in the shaft may be obtained, if exact data be possessed as to the resistances which they oppose to the water flowing through the shifting materials. That an outward current of the water actually occurs is easily ascertained by an experiment with a large glass jar filled with sand, in which, however, care must be taken that the uppermost layer of sand be covered with a straw filter, and weighted so heavily that the pressure of the water filling up the interstices do not force out the sand. Herr Schulz then describes the manner in which he carried out such experiments, which convinced him that a falling in of the sand into the bored hole cannot occur.

The action of the clay mixed with water filling the shaft, which clay serves to consolidate the sides when consisting of sand, appeared to the author to only take a second place in the success of the method; but such experiments as he made satisfied him that they are calculated to give information as to whether such action is actually exerted. He concludes, however, that the Honigmann method could be carried out at Heerlen under very favorable conditions, as the natural water level is only about 10 m. below the surface. With these conditions the necessary excess of pressure in the water filling the shaft could be obtained almost without cost, whereas it might not be so easily obtained under other circumstances.

According to official statistics there were, at the beginning of 1896, in all Europe, only 111 trolley street car lines, with a total mileage of 596 miles, and a good half of these lines were installed during 1895. In the United States at the same time there were 1,140 electric street car lines, with a total mileage of 14,850 miles and a capitalization of $900,000,000, against 312 horse, steam and cable systems, with a mileage of 2,800 miles and a capitalization of $140,000,000.

THE TONING OF BROMIDE PRINTS.

By J. PIKE.

A MINOR department of practice, which may be safely left for attention when days are dull and clients few, is the resuscitation and rejuvenation of faulty bromide proofs.

In exposing and developing a dozen or so of bromides, it is very rarely indeed that a percentage of more than eight out of twelve turn out really good and fit without further treatment. If, however, we thoroughly fix, wash, and dry the remainder—treat them, in fact, as if they were just as perfect as the others—we shall often find it worth our while at some leisure time to devote a few minutes to them, for it often happens that out of this lot of faulty wasters we can get one or more prints which really may surpass the first and selected prints in tone and brilliance. In other words, the ugly duckling may develop into a swan of wonderful plumage.

It is never too late to mend a poorish bromide, provided it has been properly fixed and washed.

I lately found, in a most unexpected place, a roll of bromide prints, 15 × 12, which, I should think, were at least seven years old—wasters presumably, and yet had evidently been stored away carefully, in the hope of a time coming when something could be done with them. They were a find in their way, being the sole remaining prints of a medal negative which had some time ago gone over to the majority.

The prints were badly stained (iridescent stains), inclined to be mouldy, had some symptoms of light fog, but were fully developed—had been developed with ferrous oxalate—and were of a greenish tinge far from pleasing.

It is clear that nothing can be done of any value if the fixing of the print has been imperfect, or if the washing has not resulted in a complete elimination of salts. The first thing to be done was, in the absence of any confidence in what had gone before, to once more fix these prints and wash them. This was done, and they were ready, after drying, for further treatment.

To tone or intensify—for that is usually what it amounts to—is never to be done in the absence of a really effective clearing bath. The surface of a bromide print—or any other film for that matter—is never in a good condition for this operation, unless it has a mild, but effective, sort of "shampoo process," which leaves it in the best possible condition to receive the action of the toning salts.

From the appearance of the stains and fog, Howard Farmer's reducer was instantly judged to be the best "clearing" agent for this purpose. For my own part, I very rarely intensify without first submitting the film to the action of this excellent bath, and in the present case the prints were, as may be expected, greatly improved. The iridescent stains cleared off, the light fog dispersed; but in one case, that of a print not so fully developed out as the others, it was cleared at the expense of the high lights, which then had rather a chalky appearance. A second washing followed, using gentle friction with wet wool at intervals, to completely clean the surface.

Three toning baths were used: First, the alum and hypo bath of the Eastman Company. Their formula is as follows: Sodium hyposulphite, ten ounces; dissolve in three and a half pints of boiling water, then add gradually one ounce of powdered alum. This bath was made and kept some days before use. It was then warmed to 100°, and two prints immersed therein. They took quite thirty-five minutes to tone, and were distinctly the better for the treatment. There was rather more reduction of density with this bath than I expected; but, as the prints were quite over-dense to start with, they were all right in the end. The prints were placed after toning in a simple solution of alum (three-quarters of an ounce to the pint of water), then washed and dried.

The second lot were toned with uranium, e. g.:

Mix freshly—

Red prussiate of potassium	4 grains.
Water	4 ounces.
Glacial acetic acid	150 minims.
Water	4 ounces.
Uranium nitrate	4 grains.

The prints were not immersed in the above, but, having been wetted thoroughly and attached, face up, to a piece of plate glass, the solution was applied by means of cotton wool, the whole of the face being well and carefully attended to. Toning proceeded so slowly with this bath that I added a few drops of ordinary "mercurial intensifier" (the usual five per cent. solution), and got, in a few minutes, a very nice dark oak tone, which admirably suited the subject. By surface toning, the risk of staining, degradation of the whites, etc., is reduced to a minimum, and washing, though thorough, need not be prolonged.

The best results were, I think, got by means of the method suggested, I believe, by Mr. Chapman Jones, viz., bleaching with mercury and redeveloping. For this purpose, a fresh bath of mercury bichloride was made, one part in forty of water. Bleaching in this diluted bath proceeds slowly, steadily, and evenly. Thorough washing follows. This is once more essential, otherwise development will be local and patchy. Redevelopment is effected with eikonogen, amidol, hydroquinone, or ferrous oxalate, but the solution must be moderately weak, the chloride image being very easily reduced. On the whole, the results were better with this method, but merely on accidental grounds. The few small, mouldy patches showed up less with this operation than with either of the others, and these, after mounting, were more easily obliterated with the pencil. The operations of redevelopment, etc., may be carried out in daylight. The prints are to be washed and dried.

It is quite clear to me, as the result of these few trials, that, with a little more care, a much higher percentage of successes in bromide printing would result. Let the prints be made the best of at the time, then thoroughly fix, wash, and dry the lot; but do not reject, without a trial and due consideration, those which may be below the mark, for something may be made of them.—The British Journal of Photography.

SELECTED FORMULÆ.

Winkelmann's Solution.—As the basis of a solution for impregnating wood used in electric installations in order to render it uninflammable, the Elektrotechnischer Anzeiger gives the following (Winkelmann's process): 33 parts (by weight) of manganese chloride, 25 of ammonium chloride in 1,000 of water, 20 of orthophosphoric acid, 12 of magnesium carbonate, and 10 of boric acid.

Salicylated Paste.—(Prof. Lassar.)

Salicylic acid	2 parts.
Zinc oxide	24 "
Starch	24 "
Petrolatum	50 "

—Am. Druggist.

Insect Bites.—The following new remedy has been sent straight from Accra, on the Gold Coast:

Ammonia water	2½ drachms.
Collodion	50 minims.
Salicylic acid	5 grains.

—Am. Druggist.

To Harden Small Drills.—The drill being filed the right size (the edge must not be hammered flat), it is moderately heated without becoming red and then plunged into borax, whereby it becomes incrusted with borax and the air is excluded. The drill may now be hardened by heating to cherry red, and finally plunged into a piece of borax, or, what is still better, into mercury, care being had not to inhale the vapor. The borax, yielding to the heat of the drill, melts and cools off the drill. The results of various experiments of cooling off the drill incrusted with borax in water, oil, etc., were not so favorable as plunging it into borax or mercury. The drill becomes extraordinarily hard, without being brittle, so that articles which cannot be worked with drills hardened in the ordinary manner can be drilled with it.

Shaving Powder.—

Powdered soap	1·250 kilogrammes.
Sodium carbonate	0·150 "
Wheat starch	0·240 "
Orris root	0·080 "
Oil bergamot	6 drops.

Instead of the orris root the same weight of powdered quillaia and a very little oil orris may be used. An addition of 10 to 20 grammes of glycerin will render the powder milder in use.

Lanolin Dusting Powder.—

Lanolin, anhydrous	5 grammes.
Ether	20 "
Dissolve and rub up with	
Wheat starch	45 "
Allow ether to evaporate, then add:	
Boric acid	2 grammes.
Talcum	50 "
Oil of wintergreen	1 gtt.
Oleo-balsamic mixture	1 "

Antichafe Nursery Powder.—

Fuller's earth	9 ounces.
Boric acid	1½ "
Zinc oxide	3 "
Starch	9 "
Orris root	1½ "
Oil bergamot	2 drachms.

Mix the powders thoroughly, then add the oil, and pass through a fine sieve.

Protective Varnish.—To protect wooden vessels against the penetration of liquids into their pores:

Shellac	1 kilogramme.
Resin	125 grammes.
Venice turpentine	125 "
Alcohol	6 liters.

The resins are fused together, and over the yet liquid mass pour the spirits. Wooden containers for hot liquids must not be varnished with this product, as it begins to soften at 70° C.—Bad. Gew.-Ztg.

Insect Powder.—A new and very efficient insect powder has been introduced in Europe. It consists simply of pyrethrum flowers, to every 100 parts of which is added one part of naphthalin by weight. The naphthalin must be in very fine powder and intimately mixed with the pyrethrum. Any druggist having the article on hand may convert it into a rapidly selling article, with a good profit. A recent analysis of a powder on the market proved it to be a mixture of pyrethrum with borax, a very effectual blatticide.

To Render Tobacco Harmless.—Dr. Gautrelet directs to steep a piece of cotton wool in a 5 per cent. solution of pyrogallic acid and insert it into the pipe or cigar holder. He claims that this method will neutralize any possible ill effect of the nicotine. Such ill effects as headache, furring of the tongue and more serious ills he claims can thus be avoided.

To Remove Tar or Pitch from the Skin.—Tar or pitch can be removed from the skin by rubbing well with pulverized licorice mixed with oil of anise, to the consistency of cream, and lastly washing with soap and water.—Nat. Dr.

Nectarine Essence or Extract.—

Butyric ether	½ fluid ounce.
Acetic ether	½ "
Œnanthic ether	½ "
Formic ether	½ "
Valerianic ether	½ "
Sebacic ether	1 fluid drachm.
Aldehyde	1 "
Glycerin	2 fluid ounces.
Cologne spirit	12 "

Mix them.

Aquarium, Cement for.—A good preparation is said to be the following, which is given by Dieterich:

Litharge	20 parts.
White sand, finest	20 "
Plaster of Paris	20 "
Manganese borate	1 "
Resin, powdered	70 "
Boiled linseed oil	suff. quan.

Mix the solids and make them into a paste with the oil.

ENGINEERING NOTES.

The Compagnie Générale Transatlantique, commonly known as the French line, will build two new express steamers for their New York and Havre service.

Nearly every English flagship carries eight and every cruiser four fully qualified divers, whose duty it is to repair any damage sustained by the vessel below the water line, clearing the propellers and recovering the anchors.

The new yacht for the Emperor of Russia is a boat of 5,200 tons displacement. Her length is 370 ft., breadth 50 ft. 6 in., and depth 33 ft. 6 in. She has been fitted with engines of 10,600 horse power, and is valued at $2,300,000.

Low level bridges have been found desirable for Queensland rivers that are subject to severe floods. The cost of high level bridges is excessive, and those of moderate height are very liable to be carried away, while the low level ones are submerged before logs and drift wood are brought down in conderable quantity, so that the dangerous debris passes harmlessly over the bridge.

One hundred and nine thousand locomotives are at present running on the earth, says the Boston Journal of Commerce. Europe has 63,000; America, 40,000; Asia, 3,300; Australia, 2,000; and Africa, 700. In Europe, Great Britain and Ireland take premier position, with 17,000 engines; Germany has 15,000; France, 11,000; Austria-Hungary, the second largest Continental country, has 5,000.

During the past year some tests of pianoforte wire were made at the Watertown arsenal. In one case the material exhibited the extraordinary strength of 206 tons per square inch, the wire in question being 1-12 of an inch in diameter; larger sizes gave a tensile strength of 135 tons per square inch and upward. The metal contained 0·85 per cent. of combined carbon. Some remarkable samples of cast iron were also tested at the arsenal during the year, one showing a resistance of 15·4 tons per square inch.

Efforts are being made to restore water communications between the Forest of Dean coalfield and London. Some years ago the canal, which crosses the Cotswold Hills and connects the Severn Canal system with that of the Thames, fell into the hands of one of the railway companies, and the pumping stations being neglected, the canal became unnavigable. It is stated that, through the joint action of the Gloucestershire County Council and the Birmingham Navigation Trust, steps have been taken to remedy the neglect, and in a short time coal will once more be brought to London by water from the western coalfields.

Of the railroad lines in operation in Japan it is said that 557·29 miles are owned by the government. According to the latest statistics, the lines under construction make up a grand total of 719·61 miles. The London and China Telegraph states that a railway project of considerable importance is reported from Kyoto, by which Tsruga, on the Japan Sea, will be connected with Kyoto by a line along the western shore of Lake Biwa, that route being shorter than the existing government road, which makes a detour along the eastern shore. The whole distance is 65 miles, and the estimated capital of the company 3,200,000 yen.

The New Decimal Association, of London, says the Age of Steel, sends out the following items regarding the growth in popular demand in England for a change to the metric system of weights and measures. The London Association for the Protection of Trade, having about 4,000 members, mostly retail dealers, has sent a petition to Parliament urging the adoption by the government of the recommendations of the select committee favoring the metric system. Other commercial bodies in Liverpool, Edinburgh, Hull, Manchester, Munster, Southam, etc., have all taken action showing them to be decidedly in favor of the proposed change. The significant feature in these petitions is that they come from bodies representing the retailers and smaller tradesmen, a class that would probably be most inconvenienced by a change in the standards, and the class from which the strongest opposition was expected.

Comparative figures of the coal consumed per car mile run on French tramways, employing different methods of propulsion, are contained in an article on electric lines by E. Cadiat, in the Portefeuille Economique des Machines. As regards storage battery traction, on the lines from St. Denis to the Madeleine and from the Opera to Neuilly, the car mileage aggregated, in 1893, 502,060, or 1,376 car miles per day. The steam engines at St. Denis furnished for this service a total of 6,500 horse power hours, or 4·72 horse power hours per car mile. M. Badois, who reported these figures, gives 2·75 lb. of coal as the consumption per horse power hour, and arrives at 12·98 lb. of coal per car mile. At Marseilles, during the first two weeks of operation of the trolley system, 150,348 lb. of coal was consumed to run 19,970 car miles, and during the second two weeks 150,975 lb. for 18,983 car miles. The average is 7·73 lb., which, however, includes the coal used in connection with the lighting of the cars and the power station.

The time when iron and steel ties will be substituted for the wooden ones, so long in use on our railroads, appears, says the Iron Age, to be rapidly approaching. An indication of this is shown in a contract recently made for ties by a street railway company in a northwestern city. It is not far from large lumber districts, yet the white oak ties which were wanted could not be obtained from northwestern woods, and southern lumbermen asked 60 per cent. increase over former prices. This was a revelation to the street railroad company and to others. Hitherto lumber suitable for ties has been so abundant, and, therefore, so cheap in America, that iron or steel ties were out of the question. But iron and steel ties have steadily cheapened in price, while lumber has grown dearer, and the pioneers in the steel tie trade may not be very far from the demand which seems destined to make its appearance. The prospects now are certainly much more in favor of metal ties than at any time in the past. When such a demand comes, it will form a very important outlet for iron and steel.

ELECTRICAL NOTES.

Siemens found that an electric arc light of 4,000 candles radiated 142·5 thermal units in a minute, while to produce this light by gas would require 200 Argand burners, which would emit 15,000 units, or over a hundred times as much.

Dr. Leonard Paget finds, says Electricity, that screens prepared with pentadecylparatolycetone fluoresce much more strongly with the Roentgen ray than do those prepared with calcium tungstate, and that the definition of the shadows is much sharper.

Connection between the mainland and Fastnet lighthouse, on the southwest coast of Ireland, has heretofore been carried on with much difficulty, owing to the fact that a telegraph cable had to be carried over an exposed rock where it was subject to constant chafing. The cable now terminates in the water, 60 yards off, and the electrical connection is completed through the water to two bare wires dipping into the sea near the rock.

It is stated, says the Electrical Engineer, that the first trolley railroad in Persia will be built from Teheran to the summer resorts, about ten miles to the north of the city, where everybody lives during the hot season. The summer on the Persian plateau is very hot and dry, and it is only in the neighborhood of the mountains that Europeans can stand the great heat. A concession for ninety years has been granted to a German contractor, who will start the building of the road at once.

The South American Light, Power and Traction Company, of Lima, Peru, has just placed a contract with the General Electric Company, of New York, for the installation of a 5,000 horse power electrical plant, says the Electrical Review. The dynamo will be erected at the water falls, 11 miles from Lima, and the electric power generated will be transmitted to the city, where it will be used to operate the surface railways and electric lights and furnish to the public generally such electric power as may be required. This will be the largest electrical installation in South America.

Experiments have been made by A. M. Bleile upon dogs in order to determine the cause of death in electric shock. The conclusion reached is that for a given animal in normal condition as to health a definite amount of electrical energy will produce fatal results. It is thought that the action of the electrical discharge is to contract the arteries and increase the pressure of the blood, and that death is due to inability on the part of the heart to sustain the increased pressure of the blood so produced. Post-mortem examinations seem to show that the passage of the current does not cause any anatomical disintegration.

Cornell University made an extensive display at the New York Electrical Exposition. Probably the most interesting single piece of machinery was the Gramme dynamo, built by Professor Anthony in 1875, and exhibited as a great curiosity at the Centennial Exposition. It was the first dynamo of practical account built on that plan. It is still used at the University, but the great changes and improvements made in dynamo manufacture make it as great a curiosity now as it was twenty years ago. Among the pieces of apparatus to be seen were a Ryan electrometer, invented by Professor Ryan of the University, and many others, either invented by Cornellians or used by them in experiments in which important discoveries have been made. Cornell has never forgotten that her founder owed his fortune to electrical discoveries, and has not rested content with naming her buildings Morse Hall, Franklin Hall, etc. From the very foundation of the University this subject has received much attention, and the dynamo laboratory is said to be still the most complete possessed by any school.

A novel departure has recently been adopted by the power and mining department of the General Electric Company. The question of coal cutting by machinery is a simple question of dollars and cents, and as mine operators are usually skeptical regarding electrically-driven machinery, something more conclusive than simple argument on experience elsewhere is necessary, as, for instance, a careful test under actual working conditions. Such a test would require a complete installation, which would be expensive. The company has designed a compact power plant which can be installed near the mine mouth. They have fitted up a box car with a forty horse power water tube boiler, high speed engine, and three-phase generator of 75 kilowatts or 100 horse power capacity wound for 550 volts and running at 900 revolutions. It is belt driven to the engine. A multiphase motor actuates the coal cutting machine. In practical tests the average weight of coal undercut per hour was not less than twenty-three tons. The cutter itself is a chain machine. The capacity of the motor is 20 horse power, but the consumption of power under ordinary conditions is between six and seven horse power.

The United States lighthouse board has demonstrated that telephoning can be carried on at sea with vessels near shore. An iron armored submarine cable was laid from Sandy Hook at the power station of the Gedney Channel Electric Buoy System, out to the Scotland Light Ship, five statute miles, of which one-half mile was underground across the Hook. A copper wire gridiron arrangement was fixed at the end of this cable, and by this and other methods, an electrical diffusion area was created, different electrical potentials, sufficient for practical purposes, being found at any two points 100 feet or so apart on the water's surface. The lighthouse tender Gardenia, suitably equipped with transmitting and receiving circuits, found that there were over sixteen acres of water around the lightship throughout which telephonic conversation could be carried on with Sandy Hook station, and while under full steam. As the Gardenia has a wooden hull without sheathing, two plates of sheathing metal seven feet by three feet were attached to bow and stern, and wires run from them to the pilot house. The plates were about 113 feet apart, and sufficient potential difference existed over the sixteen acres to operate the telephone well.

MISCELLANEOUS NOTES.

An aluminum boat for sportsmen's use has been made; it weighs but thirty pounds, is fourteen feet long, and will carry two people.

From the wells in the Apscheron peninsula in the Transcaucasus, the Baku district, the Russians drew 317,400,000 poods (36 pounds each) of naphtha oil during ten months of 1895 to 247,700,000 poods during the same period in 1894. The increase was due not so much to the boring of new wells as to the stronger flow from the old ones.

The Russian petroleum trade was badly injured last winter by inundations which interrupted for weeks the working of the Transcaucasian Railroad, which extends from the petroleum wells on the Caspian to the Black Sea, through what were formerly known as Circassia and Georgia. There is now serious talk of a pipe line to connect with a railroad north of the Caucasus.

A Hall of Honor has been established in the Val de Grace Hospital in Paris, where the names of French medical men who died in the performance of their duty are inscribed on marble tablets. A list of 143 doctors and forty-five apothecaries has just been placed on its walls, all of whom perished in the yellow fever epidemic in San Domingo and Guadalupe in 1801-1803.

In order to still further carry out certain recommendations of the recent committee on prisons, the directors of English convict prisons have decided that, with a view to raise the moral tone and relieve the monotony of the life of convicts undergoing long sentences of penal servitude, lectures on scientific and interesting subjects shall be periodically given, and arrangements are in progress for giving early effect to this innovation.

Cremation appears to be growing in favor in this country. According to the Tribune Almanac there are twenty-six associations in active operation in the United States. The oldest was organized at Washington, Pa., in 1876, and the two newest were founded at New Haven, Conn., and Elizabeth, N. J., in 1894. The number of incinerations is reported as 3,670. The number incinerated in Europe from 1876 to 1893 was 19,700. The membership of the American associations about 8,000, and the adherents of the method about 100,000.

The United States last year imported 189,785,157 pounds of tea, worth $27,302,865, or an average of a little less than fifteen cents a pound. This is more than twice as much as was imported in 1893. It came from China, 54,700,393 pounds, worth $7,534,534; Japan, 36,941,394 pounds, worth $4,601,041; Ceylon, 9,283,144 pounds, worth $1,485,303; England, 3,622,844 pounds, worth $743,980. The average value has not changed in four years. The consumption is about two pounds and a half per capita, against four pounds in England, sixteen pounds in Russia, and thirty pounds in China.

Of French journals the oldest is the Petites Affiches, now 284 years old; the oldest political paper is the Gazette de France, founded under Louis XIII. and now 267 years old. Two other newspapers, the Moniteur Universel and the Journal des Debats, are centenarians, dating from 1789. The Restoration has left the Constitutionnel and the Univers; Louis Philippe's reign the Charivari, Presse, Siècle, and Patrie; the Pays dates from the revolution of 1848; the Figaro, Monde, Temps, France, Liberté, National, Soir, Petit Journal, Officiel, Petite Presse, and Petit Moniteur from the Second Empire.

The Boston Flower Market states that, owing to the filling in of portions of Boston Common by using the material from a subway, the surface has been raised to four feet or more above its former level in some places. To save the beautiful shade trees that had been sunk several feet below their natural level has been the work that has engaged Supt. Doogue's attention for some time. The size of the tree played little part in the proceeding. A circular trench was first dug about the tree at a sufficient distance from the trunk that the roots suffered little disturbance, and it was sunk to a level considerably below the larger roots. When the ball of earth around the tree was thoroughly frozen, it was lifted in much the same way as is employed in the raising of a building. When raised to the proper level the space beneath the ball was filled with earth, carefully tramped down, the trench filled, and the work thus completed. Thirty-one of the largest trees raised vary in weight from eight to forty-six tons. The proportions of the largest trees raised are as follows: Diameter 2½ ft., circumference 7½ ft., height 80 ft., and spread 60 ft.; diameter of ball 15 ft., depth 5 ft., and weight 46 tons.

The State of New York maintains what may be called "a traveling library," says the Home Journal. It is under the control of the public libraries department of the University of the State of New York, and consists of a box of books, twenty or fifty in number, which will be sent to any reputable citizen in any city or village upon application to that department of the State government at Albany. A school teacher, for instance, may have this "library" sent to him for circulation among his pupils or the members of their families at a cost so small that an assessment of five cents a month will cover all expenses. With the books is an oak bookcase, a lock and key, and a cabinet to hold books, cards, and readers' cards, both of which are supplied. He will also receive a supply of little printed catalogues, containing the titles of all the books in the library, with comments on their contents. The library may be kept for six months. Upon its return another may be secured. A fee of three dollars for fifty books and five dollars for one hundred volumes covers all expenses of transportation and everything else. Reports to the regents of New York State in 1895 show that there are in the State 181 free circulating libraries of 1,000 volumes or more, a gain of twenty-five over 1894. Eighty-three thousand two hundred and seventy-eight were added to these libraries in the year, and their circulation increased from 2,665,000 volumes to 3,012,000 volumes. The gain in circulation for libraries of this class was 347,425 in one year and 762,122 in two years. The average circulation was 261 for each 100 volumes in 1894 and 287 for each 100 volumes in 1895.

[Continued from SUPPLEMENT, No. 1065, page 17028.]

AUTOMATIC FIRING GUNS.*

By HIRAM STEVENS MAXIM.

II.—INTRODUCTION OF RIFLING.

ELLIOT'S carbine, which is illustrated in Fig. 21, was designed expressly as a carbine, and has a mechanism which may be operated with one hand. After firing, the hammer, d, is drawn back to the position shown in S, and in so doing draws back the yoke, b, upon the breech block, a, to which it is pivoted at c. This pulls down the front end of the breech block, exposing the rear of the barrel for the insertion of the cartridge. Having done this work, the pin, e, of the yoke slips out of the socket, f, into the lower portion of the groove, while the lower branch of the yoke engages the pin, g, so that when the hammer is again pulled back the breech block is again pushed up into the position shown at S'. One pull on the hammer depresses the breech block and ejects the empty shell; another pull closes the breech block, and puts the hammer in position for firing. A pull on the trigger fires the arm.

Fig. 22 illustrates the United States Springfield musket; this arm operates in a manner similar to the old English Snider. The breech block is pivoted to the barrel, and moves upward and forward, leaving an opening sufficiently large to enable the cartridge to be inserted in the barrel with facility. The breech block may then be returned into firing position, and the arm fired. A lock with an ordinary hammer is employed. This arm has been very extensively used in the United States army.

The Ward-Burton breech loading rifle, illustrated in Fig. 23, is a bolt gun, operated in very much the same manner as the Prussian needle gun, except that it employs metallic cartridges with a primer. At some competitive trials which took place in the States, it is said to have given a very good account of itself. It, however, was never adopted into any service.

The Remington long range target rifle, illustrated in Fig. 24, was made expressly for long range shooting, and never has been employed as a military rifle.

Fig. 25 represents the Remington magazine rifle; this arm has an ordinary bolt action, and a tubular magazine placed beneath the barrel. A spiral spring forces the cartridge from the magazine into a spoon shaped lever, which is articulated to the shoe of the gun. As the bolt is brought forward, it forces the loaded cartridge into the barrel. The opening of the breech cocks the hammer. This arm has many features common to the French Lebel rifle of to-day.

The Hotchkiss magazine rifle, which is illustrated in Fig. 26, has an ordinary bolt action; the magazine, however, is placed in the stock of the arm, and the cartridges fed into position in the manner shown. It was objected to by military men on account of its being heavy and clumsy. Moreover, all fire arms of this kind require a considerable time to charge the magazines, so that the rate of fire in many cases is not equal to single breech-loading rifles, especially when a large number of consecutive shots have to be fired.

Sharp's long range target rifle, illustrated in Fig. 27, was constructed expressly for long range shooting. Metallic cartridges were used; they were of great length, some of them having a powder charge of one hundred and five grains. On account of its excellent shooting qualities it was very popular among sportsmen for many years.

Perhaps no arm ever invented has had so extended a use as that enjoyed by the standard Remington military rifle, illustrated in Fig. 28. At one time it was supplied in large numbers to nearly all the nations in the world who were unable to make their own rifles, and to-day it is the standard arm with all the native races of Northern Africa, and is employed to a great extent in South America and Asia. It might be said that the breech action of this gun consists of two hammers—that is, two pieces of steel, one acting as the breech block and the other as the firing hammer. Both are very firmly pivoted to the shoe of the gun. After inserting a cartridge in the barrel the first of these two hammers may be turned forward, and by pulling the trigger the second locks the first one in position and then fires the charge. By an ingenious device the trigger cannot be pulled until the breech is closed. The great simplicity of this arm is probably the reason why it was so well received by the semi-savage races of Asia and Africa.

A considerable number of these arms are now made in Placencia, in Spain, and sold for about two dollars apiece, the barrels employed being rejects from Belgium, while the mechanisms are of malleable iron. They are, however, marked "Manufactured at Ilion, New York," and have the dates of all the Remington patents stamped upon them. The makers assured me that they were unable to sell these guns in Africa unless they were stamped with Remington's name.

In Dodge's breech-loading shot gun, illustrated in Fig. 29, the barrel is pivoted to the stock; the rear end is held down by a lever, which forms part of the trigger guard. Upon detaching this lever and pressing it down, it not only unlocks the rear end of the barrel from the shoe of the gun, but at the same time elevates it, and extracts the spent case. By pulling the trigger guard back into position, the barrel is also pulled downward into position and locked. In other respects it resembles the breech-loading shot guns of to-day.

Fig. 30 represents the Swiss magazine rifle; this arm is provided with a tubular magazine beneath the barrel, the same as in the Winchester. It also employs the same method as the Winchester for transferring the cartridge from the magazine to a position in line with the bore. An ordinary sliding bolt, carrying the firing pin and operated by hand, is employed for pushing the cartridge from the carrier into the barrel, for locking the breech and firing the charge. The to-

* From Industries and Iron.

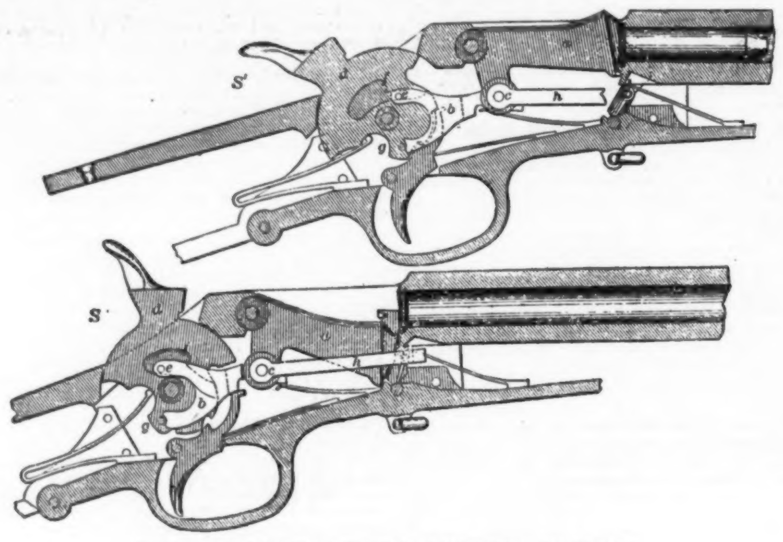


FIG. 21.—ELLIOT'S BREECH-LOADING CARBINE.

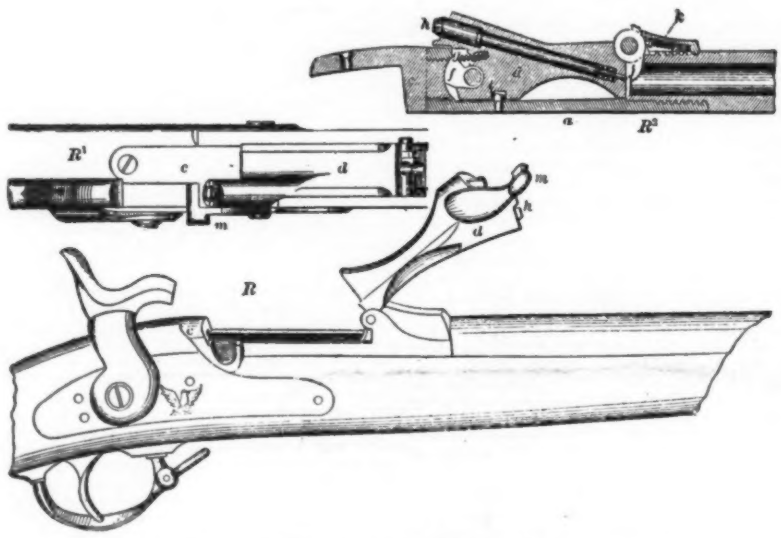


FIG. 22.—THE UNITED STATES SPRINGFIELD RIFLE.

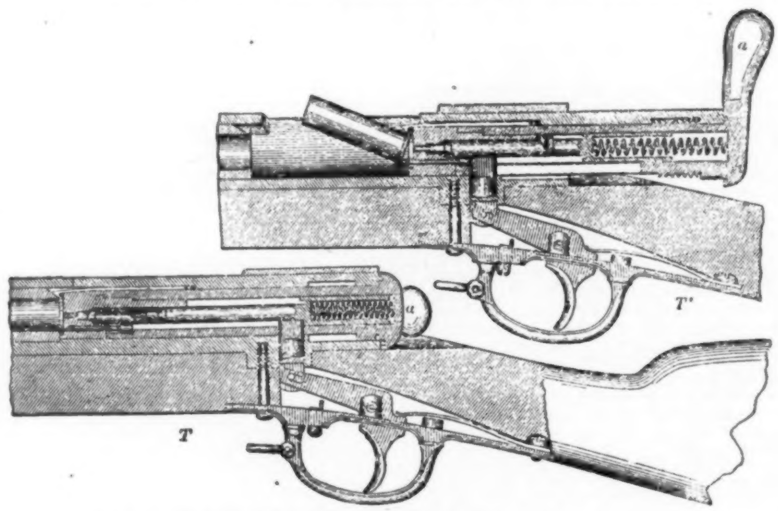


FIG. 23.—THE WARD-BURTON BREECH-LOADING RIFLE.

FIG. 24.—THE REMINGTON LONG RANGE TARGET RIFLE.

FIG. 25.—THE REMINGTON MAGAZINE RIFLE.

FIG. 27.—SHARP'S LONG RANGE TARGET RIFLE.

FIG. 26.—THE HOTCHKISS MAGAZINE RIFLE.

FIG. 28.—THE STANDARD REMINGTON MILITARY RIFLE.

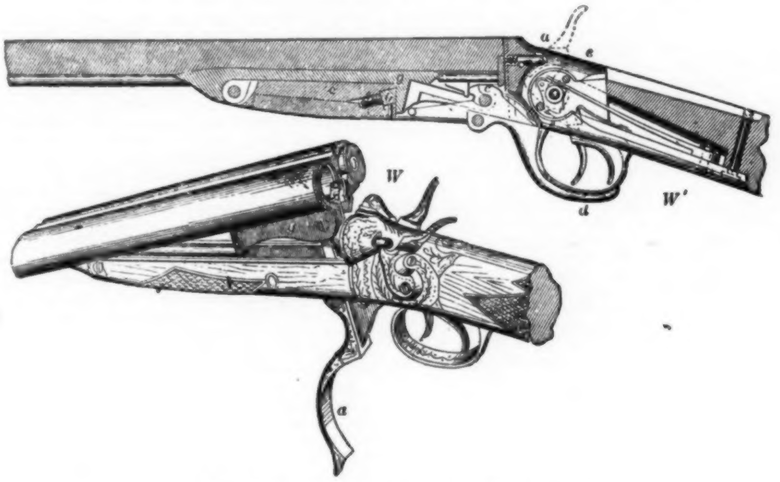


FIG. 29.—DODGE'S BREECH-LOADING GUN.

FIG. 30.—THE SWISS MAGAZINE RIFLE.

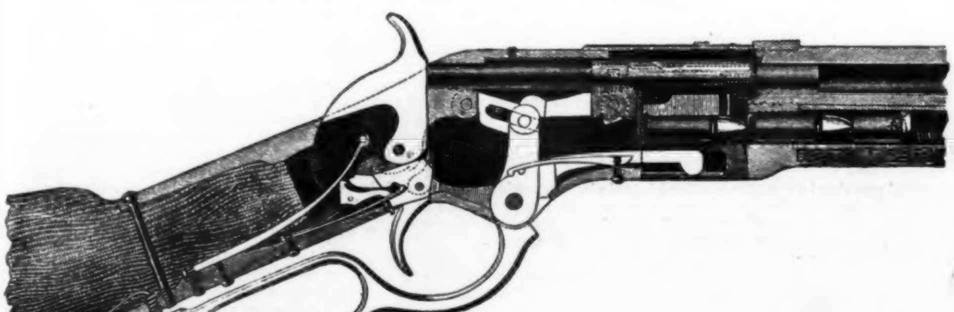


FIG. 31.—THE WINCHESTER REPEATING RIFLE, MODEL 1876.

and-fro movement of the bolt elevates and depresses the cartridge carrier.

The well-known Winchester repeating rifle (model 1876) is shown in Fig. 31; this was the first repeating magazine rifle to go into general use all over the world, not only as a sporting arm, but also as a military carbine and rifle. The cartridges are placed in a tubular magazine beneath the barrel, and pushed to the rearward by the action of a long and weak spiral spring. By depressing the lever which forms the trigger guard, the bolt is withdrawn, the cartridge case extracted and expelled from the arm, and at the same time the hammer cocked and a fresh cartridge brought into position. By returning the trigger guard into its original position, the bolt first pushes a cartridge into the chamber and then depresses the carrier, so that it comes opposite the cartridge in the magazine, when a new cartridge is driven into the carrier by the action of the spiral spring. The breech block is held closed by a toggle joint, which is articulated to the upper end of the lever which forms the trigger guard. The magazine holds from five to twelve shots, and the arm may be fired with great rapidity.

(To be continued.)

THE BESSEMER PROCESS AGAIN—REPLY OF JOSEPH D. WEEKS TO HIS CRITICS.

To the Editor of the SCIENTIFIC AMERICAN:

I have delayed answering the criticisms on my address as President of the American Institute of Mining Engineers on the "Invention of the Bessemer Process" until I could carefully consider the objections urged against the claims of William Kelly, and especially until the "argument by abuse" had been exhausted. The question at issue is one of fact, to be settled by the rules of evidence and not by abuse or denunciation or the demolishing of "claims" that were not advanced by me. I have carefully read every written and published word in reply that has come to my attention and have as carefully reconsidered all the evidence offered as well as other that has been brought to my notice. This has only served to strengthen the conviction reached after careful investigation more than twenty years ago, a conclusion in which I was at one with many of the most prominent steel and iron makers of the United States at that time, viz., that William Kelly was the inventor of what Holley described as the essential feature of the Bessemer process, which was for many years known in this country among many steel and iron makers as the pneumatic or Kelly process.

As so many things have been disputed which I did not assert, may I state just what I did claim in my address?

First, accepting the definition of Holley, I claimed that the essential feature of the Bessemer process was "the decarburization of crude cast iron by the air blast in a vessel independent from the blast furnace or furnace in which it was melted, and without the application of external heat."

Second, that the invention set forth in the patents under consideration of both Bessemer and Kelly was covered substantially by this definition.

Third, that Kelly, and not Bessemer, was the original inventor of the process so far as it is covered by this definition.

In proof of this claim I adduced:

First, the statements under oath of 22 persons taken in the interference case between Kelly and Bessemer in 1856–57, who testified of their own knowledge that in 1847 and 1851, and later, Kelly described and practiced this invention.

Second, decisions of the Commissioner of Patents of the United States in at least two cases in which it was decided after extended hearings and investigations that Kelly, not Bessemer, was the original inventor.

Third, the statement under oath of A. L. Holley that he considered Kelly's invention the first practical development of the process.

It will be noted that all of this evidence is either the decisions of sworn officials or is given under oath at legal hearings, when false swearing would be both moral and legal perjury. In discussing Kelly's claim to be the original inventor, I purposely and rigorously confined myself to this evidence, all of which is a matter of record and not of memory.

Just here let me say that I have no desire, nor have I attempted to "whittle down the Bessemer process" nor to sum it up in the words "blowing air into iron." If the question of the invention in its entirety of the Bessemer process as it is understood to-day were the point at issue, Sir Henry Bessemer is certainly not its sole inventor. He did not invent the Mushet feature, the use of the triple compound, and the production in the United States of as much as 4,160,072 tons of cast steel ingots in 1892 (not 1872, as Sir Henry states) would have been impossible without Holley's inventions for quick working. I purposely and properly confined my claim for Kelly to what has been called the pneumatic feature, and which Holley characterized as the essential feature of the process.

What is the answer of my critics to my claims? To the first it is that these men did not know what they were talking about; that they were unworthy of belief; that their testimony was "vague" and has been discredited.

I reply that on no single statement of fact has the testimony of one of these men been impeached or discredited, though the opportunity was afforded Bessemer to so impeach this testimony both when the patent was originally granted to Kelly in 1857 and when the application for the reissue of his patent was before the Patent Office fourteen year afterward, in 1871.

In the interference suit in the Patent Office between Kelly and Bessemer in 1856-57 Bessemer was represented by the late Mr. R. H. Eddy, the attorney who secured his patent. This attorney in a letter dated February 26, 1857, professed his ability to show that "Kelly did not make the invention." The only evidence submitted in Bessemer's behalf to justify this assertion, so far as I have been able to ascertain, was a copy of the Artisan of September 1, 1856; of the London Times of August 14, 1856; and of Bessemer's English patent of October 17, 1855, No. 2321. The only claim made for this evidence was that it proved that Bessemer made his invention before October 17, 1855. There is not in the files at Washington, so

far as I can discover, one word of testimony to show that "Kelly did not make the invention." There is not a word of testimony, and never has been, to impeach the veracity of Kelly's witnesses, and when on April 13, 1857, the Commissioner of the United States Patent Office decided the question of priority of invention in favor of Kelly, and ordered a patent to issue to him unless an appeal was taken by Bessemer within sixty days, no appeal was taken, and Bessemer allowed the decision of the Patent Office in favor of Kelly to stand unchallenged, at least in the only legal way in which it could at that time be questioned.

In a word, the testimony of these men as to the facts set forth in their affidavits was uncontradicted by competent testimony at the time, and is to this day, after forty years. It is not vague, and if the testimony is one-sided, as Sir Henry asserts, it is his fault. He had his day in court, his privilege to cross-examine and his right of appeal, and he exercised none of them. Under such conditions it is simple justice and strictly in accord with the rules of evidence to assume that these men told the truth. If they did, Kelly invented this process in 1847, at least seven or eight years before Bessemer's earliest date.

My second line of proof was the decisions of the United States Commissioner of Patents. First, in the interference suit in 1856-57; second, in Kelly's application for an extension of his patent in 1871. The wording of these decisions, so far as relates to the point in question, was as follows. In 1857 the Commissioner said:

"It appears that by the concurrent testimony of numerous witnesses Kelly made this invention and showed it by drawings and experiments as early as 1847, and this testimony appears to be reliable in every respect. . . . Priority of invention in this case is awarded to said Kelly."

In 1871 the examiner reported: "Kelly's own statement of the history of his invention is full and clear, and when taken in connection with the statement of the witnesses, seems to be both intelligible and truthful."

These two cases are, so far as I am aware, the only times when priority of invention has ever been directly or indirectly submitted in the United States to a legal or quasi-legal decision, and the decision was against Mr. Bessemer in both cases.

The answer by my critics when they meet this point at all is that they have but little respect for the decision of our Patent Office and judges; that is, these critics not only abuse the plaintiff, his counsel and witnesses, but the court as well. In such cases it is generally regarded that the defendant has a very bad case. I am aware that the decisions of our Patent Office and courts do not run in Great Britain, but they do here, and have force. Under these decisions, the patent of Bessemer having been superseded and made invalid, so far as the Patent Office was concerned, by the Kelly patent, it may be said that in a certain sense not one ton of steel made in the United States was ever made under the Bessemer patent in question. It was made under Kelly's patent, which the Patent Office had decided to be the valid one, and after the extension of 1871, Bessemer's patent having expired and Kelly's being extended and being the only one in existence, all steel was made under it until it expired in 1878 and Kelly was paid royalty.

Third, in answer to my claim that A. L. Holley regarded Kelly as the original inventor, the answer is that this is not true and that in making the assertion I am "throwing mud" upon the reputation of Alexander Lyman Holley. Extracts from letters of Holley are quoted against me.

In the appendix to my address before the American Institute of Mining Engineers I give in full an affidavit of Holley's made in 1871. Question 9 in the affidavit and the answer were as follows:

"9. What do you consider the value of the invention of Mr. Kelly in its relation to the pneumatic or Bessemer process as at present practiced?"

Answer. "I consider Kelly's invention the first practical development of the pneumatic process, and it has been so recognized by the owners of the combined patents covering this process."

If any man in the world knew both sides of this controversy, Alexander L. Holley was that man. He knew all the facts; he was fully competent to give an intelligent decision on the merits of the case; he was an able engineer; he was an honest man. He declared under oath in 1871, when the subject was fresh in his mind, that he considered "Kelly's invention the first practical development" of the pneumatic or Bessemer process. If Holley was competent to decide this question, and if he knew the facts, and no one dare deny either, there is no escape from the conclusion that Kelly's invention was the first practical development of this process.

A correspondent quotes in Engineering a letter of Holley's to show "what he had to say on the claims of Kelly as a first inventor." There is not one word in that letter that contradicts the position I have assumed. Indeed, it confirms my position. Mr. Holley says, for example: "The patent of William Kelly, of Kentucky (controlled by Mr. Ward and his associates), for refining crude iron by blasts of air antedates the Bessemer patent in this country." It was this patent that covered the invention which Holley declared to be "the first practical development of the pneumatic process."

In this letter of Holley, Bessemer is nowhere described as the inventor of the process, but as the "perfecter and introducer."

"It is proper to remark here," said Mr. Holley, and the correspondent puts it in italics, "that to Mr. Bessemer is awarded in this country the chief credit for perfecting and introducing the process that bears his name here and all over the world." This does not say the "inventor" nor does it give him the entire credit, but the "chief credit" for perfecting and introducing the process. He even shares this with others in Holley's mind.

There is nothing in this letter of Holley to even throw a doubt on the statement in Holley's affidavit that he considered "Kelly's invention the first practical development of the pneumatic process."

I might rest my case here. Indeed, I have been strongly urged to do so as a "matter of courtesy" by some of the most prominent metallurgists and steel makers in this country, who are aware of the strength of certain evidence in my possession to which I have not even referred. Simply as a matter of courtesy, and not that I have no answer, I have concluded to take this advice and not answer in detail Sir Henry Bessemer's letter, except briefly on two points.

First, the "one-tuyere-vertical-blowing-downward" converter, of which Sir Henry makes so much as the "first converter," was not Kelly's first converter, but the first built at Cambria Iron Works, and was so described by me. Mr. Kelly describes his first converter as follows:

"The first converter used at the Suwanee Furnace was a square brick structure about 4 feet high. Inside the converter was cylindrical, about 15 inches in diameter, with a concave bottom, in the center of which was a tile perforated with small holes for tuyeres. In this tile was a small air chamber into which the blast pipe entered." Mr. Kelly states that the converter charges in this vessel were 100 lb., but he was troubled with weak blast, as he was in the six or seven other converters he built on a somewhat similar design, the metal clogging the tuyeres, and he was led to place tuyeres in the side near the bottom. He also had the selfsame trouble with his iron that Bessemer did.

Second. The impression is conveyed in the replies to my address that mine is the only discordant note that has ever been heard in this chime of universal praise to Bessemer. I have already quoted what Holley and the owners of the combined patents in the United States thought and said. If one acquainted with facts had been asked who from 1860 to 1870 were the most intelligent and most prominent metallurgists and iron manufacturers in the United States, among the first dozen would have been named James Park, Jr., of the Black Diamond Steel Works, Pittsburg; Capt. E. B. Ward of Detroit, Michigan; D. J. Morrell, of the Cambria Iron Works; Bernard Lauth, the inventor of cold rolled shafting; and William M. Lyon, of the Sligo Iron Works, Pittsburg. Each of these is on record as expressing the belief that Kelly, not Bessemer, was the inventor of the process. Mr. Park, in a lecture in 1872, said: "To Mr. Kelly, of Pittsburg, justly belongs the honor of having been the first to discover . . . the great principle of the pneumatic or Bessemer process."

All through the years since 1857, Kelly's claim has not been allowed to slumber, but has again and again been restated.

As this letter is being written, Mr. William Metcalf, formerly of the Crescent Steel Works, a gentleman who has been president both of the American Society of Civil Engineers and the American Institute of Mining Engineers, has published a work on "Steel," in which, after briefly referring to Bessemer's desire to make steel for guns and his invention, he says: "At about the same time or a little earlier Mr. Kelly, of the United States, devised and patented the same method. Both of these gentlemen demonstrated the potencies of their invention, and neither brought it to a successful issue."

In this connection it may not be amiss if I quote the words of Zerah Colburn, who has been summoned as a witness by my critics. In the Engineer of December 23, 1864 (I quote at second hand, as I have no copy of the original), he says: "It should be stated here that the first experiments in the conversion of melted cast iron into malleable steel, by blowing air jets through the mass in fusion, appear to have been made in 1847, by William Kelly, an ironmaster at the Suwanee Furnace, Lyon County, Ky., United States.

"It is notorious that the conversion of iron in this manner at first required great experimental knowledge to make it successful, and Kelly, no doubt, soon found what difficulties were in his path. In June, 1857, however, after Mr. Bessemer had obtained an American patent, Kelly, having conclusively proved his priority of invention, also received a patent, in a form which virtually annuled that held by Mr. Bessemer for the States. It would be natural to say that there was an evident injustice in ranking an abandoned experiment before an invention which, now at least, has become successful."

It is but just to Mr. Kelly to state that he denied abandoning his experiment.

Let me say in conclusion that I have no desire to detract in the least from the credit that is justly due Sir Henry Bessemer. Holley was right when he gave such generous praise to him as the "perfecter and introducer" of this process. His mechanical appliances for the working of the process are deserving of the highest praise, as are the persistence and intelligence with which he set himself to work to make the process a success, when, as he and Longsden so graphically state, the process was "pronounced by the iron trade a complete failure," and when the largest iron manufacturers in Great Britain, "who had already negotiated terms for the use of the process, joined in its condemnation and abandoned all ideas of experimenting therewith." Indeed, it was not until 1863 that the first royalty was paid, by John Brown & Co., the first licensees who got to work successfully in England. It is to this persistence and intelligence that much, if not all, of the final success of this process in the world is due.

JOSEPH D. WEEKS.

Pittsburg, May 14, 1896.

[Continued from SUPPLEMENT, No. 1065, page 17018.]

THE CHEMICAL LABORATORIES OF GERMANY.*

By Prof. A. B. PRESCOTT, University of Michigan.

HISTORIC LABORATORIES.

OF still greater interest were the historic laboratories. I revisited the building at Bonn, whose fair proportions have often been portrayed in miniature as a symbol of the era of laboratory study. Built in 1864 under A. W. Hofmann, when the latter first came back from his great work of 17 years in England, the laboratory was talked about in all lands. It was planned by Hofmann, who had been a student at Giessen when the pioneer of laboratories was built for Liebig in 1828. In fact Hofmann's father had been the university architect at Giessen. But Hofmann did not stay at Bonn, not even to start the work, for the reason that he was called to succeed Mitscherlich at Berlin, being himself succeeded at Bonn by Kekule. August Kekule had been privatdocent at Heidelberg and chemical professor at Ghent, when in 1865, at the age of thirty-six years, he took charge of the Bonn laboratory. He had been influential in respect to theories of molecular constitution at the world's congress of chemists, held in Karlsruhe in 1860. He had commenced a Lehrbuch of organic chemistry (1859), of which only three volumes were published; and though the work was never completed, it has become classical as an original treatise. About five years later (before 1870) he came to Bonn. Kekule's theory of closed atomic chains was then before the scientific world, and has held undisputed sway ever since. I entered the laboratory at Bonn just in time for a lecture by Kekule, whom I had not seen before. He is a man of fine and commanding presence, deliberate in manner, clear in statement, now and then pausing or repeating for emphasis. That particular morning he made no experiments on his lecture table, which, however, was well covered with material for illustration. Few American students go to Bonn for chemistry, but Prof. Kekule's assistant, Mr. Parlato, was an American, who had taken his degree at Bonn. As for the interior of the laboratory, I must confess that it is the worse for wear. In 1872 it appeared to be as fair and orderly within as it was chaste and stately when seen from without. In 1894 the workrooms and their equipment were not such as to be very inviting to the observing chemist, or to any one else,

LABORATORIES AT BERLIN.

At Berlin the First Chemical Laboratory is a plain and substantial structure, close upon the street, and with but little distinction from the adjoining buildings on the block. It faces Georgenstrasse and the steam car tracks, while its rear adjoins the university library on Dorothenstrasse, a long block from the "Linden." The workrooms are numerous, but not spacious; some of them are good and some are rather shabby; there are many small rooms for distinct researches, and a fair provision for special operations.

The library of the German Chemical Society is in this building; it is quite limited, and is suitable for laboratory reference only. For full chemical reference the students must needs go around the square to the University Library, or further, across the "Linden," to the Royal Library. The halls joining the several parts of the laboratory are tortuous, in some places dark, and in others beset with stairways. The main part of the building was erected in 1867, and when I saw it in 1872 it was in more harmonious proportions than it now is, though I could not ascertain just how the building had been enlarged. A. W. Hofmann was its director from the laying of its corner stone until his death in May, 1892—a period of about 27 years. I found several American students working there, and they regarded their opportunities as of a high order. The Harvard chemical graduates go to Berlin more than to other laboratories in Germany.

A YOUNG PROFESSOR.

Prof. Fischer has the largest chemical lecture room I have ever seen. It can seat over 400, about one-third being provided for in a gallery. About 300 were listening to Prof. Fischer's lectures when I was there.

It is remarked that Emil Fischer is unusually young to have been called to this post, the most responsible chemical position in Germany.

His reports on research began in 1875, and soon followed thick and fast. The most important ones are, first, those on the hydrazins; then those on the xanthine derivatives; and, lastly and overwhelmingly, those on the sugar group. Two years ago he went from his working laboratory at Wuerzburg to the more executive duties at Berlin.

HOW FISCHER LOOKS AND LECTURES.

He is an erect man, above medium height, with a black full beard and a broad white forehead. He lectures to the 300, to the larger audience who are beginning the subject; not to the few who are in the chemical "arbeiten." He admits but few articles of illustration upon his long lecture table; but an assistant stands at each end, and the few experiments which he introduces are made slowly, with a sort of sustained dramatic effect. He is clear and emphatic—indeed they speak of him as eloquent, but he leaves out detail, and avoids complex things. During the hour he does not put more than eight or ten formulæ on the board, each formula being a text, standing unerased to the end of the lecture.

Prof. Gabriel is one of Fischer's associates, and I had the opportunity of visiting his "colloquium" on organic chemistry. It was "privatissimum," to a class of eight or ten candidates, preparing for examination. It was a delightful quiz of an hour and half, mainly on an assigned portion of the subject, but with free discussion, all in a logical development and in a most cheerful and unconventional manner. The text was Bernthsen, which Prof. Gabriel had in his hand, but by no means followed. The Second Chemical Laboratory is under the direction of Landolt, an authority in physical chemistry, and somewhat devoted to inorganic and analytical work. It is an unpretentious little building on Bunsenstrasse, a new street with a chemist's name. The classes in qualitative and quantitative mostly work here. Prof. Landolt lectures on several subjects, and last semester had inorganic chemistry at the same hour taken by Prof. Fischer for organic chemistry. He is not an easy lecturer, nor generally acceptable in a lecture room. His name will be recognized from his joint authorship of Landolt and Boernstein's tables of chemical constants, which we find so useful.

THE CHEMISTS OF THE POLYTECHNIC.

The Polytechnicum, at Charlottenburg, just at the outer border of the Thiergarten, the great park of Berlin, is closely affiliated with the university, and its chemical opportunities demand mention. The building is new and large, and both exteriorly and interiorly is worthy of the highest commendation. To describe it would take an evening. It includes various little laboratories of chemistry and chemical technology, each accommodating two to six workers, and

* The Phi Chi Communicator.

with every known appliance for the required operations.

The two most eminent of the chemists here are Otto N. Witt, the coal tar dye authority, and Liebermann, the pyridine chemist. Witt was teaching porcelain production, and the building is only a quarter of a mile from the Royal Berlin Porcelain Works. Prof. Witt was one of the two German special commissioners at the World's Fair, and he has published a most entertaining report, embodying also an estimate of the chemical manufacturing probabilities in America, and a high tribute to the chemical achievements of American metallurgy. Liebreich in pharmacology, and Kossel in physiological chemistry, are authorities of great interest. Tiemann on the chemistry of perfumes, Rimbach on optical methods for chemical ends, Traube on chemical crystallography, Freund on the chemistry of foods—these are but a few of the many chemical specialists whose classes are open to university students.

THE GERMAN CHEMICAL SOCIETY.

The monthly meetings of the German Chemical Society are held in Prof. Fischer's lecture room. Here it was that A. W. Hofmann presided from the very organization of the society until his death. The attendance is a scattering one of thirty to fifty out of a large membership.

By a new and improved arrangement, each paper is presented in oral abstract by an appointed reader, if the author be not present himself. The discussions at the July meeting were prompt, brief, and to the point, and fifteen or sixteen subjects were disposed of in one and one-half hours.

LEIPSIC LABORATORIES.

At Leipsic the First Chemical Laboratory, built in the last of the sixties, conducts a great variety of advanced work, under a good corps of teachers, with Wislicenus as director. The equipment is good; there are sufficient smaller rooms for classification of methods, and there is a constant lookout for improvements; but there is neither elegance nor a very strict maintenance of neatness. Wislicenus, who was rector (presiding officer) of the university last year, is a model of helpfulness to visitors, and his lectures are the perfection of good teaching and masterly grace.

The Second Chemical Laboratory, that of Ostwald, the author and editor in physical chemistry, has not yet a separate building, but is quartered in half a dozen smaller rooms of the Agricultural building. Ostwald gives, besides other lectures, a free public course of lectures on the forces once a week. The majority of the American chemical students at Leipsic, when I was there, were from the Johns Hopkins. They used the one laboratory or the other, just as they would use one or another branch of the same laboratory.

THE TEACHERS AT MUNICH.

At Munich the chemical laboratory, Von Baeyer's, is on Arcisstrasse, with neighboring botanical grounds; and though not new, it is a commodious building, well provided for a large amount of the best work. It cherishes the working places of Liebig, who was there for the last twenty years of his life (until 1873). The chief associates of Baeyer are Pechmann and Kruess* in analytical and inorganic chemistry, Koenigs and Thiele in organic. Prof. Hilger, the pharmaceutical chemist, is at Munich. I saw Mr. Sherman, formerly of Ann Arbor, and Mr. Faust, formerly at Baltimore, both at work as chemical students. I heard Prof. Baeyer and Dr. Kruess lecture. Baeyer's lectures aim at placing the foundations of his subject, that is, chiefly at clearly setting forth the first principles of chemistry, and are given plainly without great illustration. The "arbeiten" in Munich are mostly directed by the associate professors. I am informed that the required preparation for "arbeiten" is of a high standard.

NUMBER OF STUDENTS AT THE UNIVERSITIES.

The largest three of the German universities compare as follows:

Berlin, total 4,025, in chemistry as leading study 205, equal to 5 per cent. of all.

Munich, total 3,464, in chemistry as leading study 140, equal to 4·19 per cent. of all.

Leipsic, total 3,067, in chemistry as leading study 114, equal to 3·7 per cent. of all.

At Heidelberg the new laboratory, to which I have already referred, is spacious, orderly and admirably equipped. The old part, however, is still used throughout, and its interior has become very shabby. Prof. Bunsen, now 83 years of age, who has given personal instruction to great numbers of men now eminent in chemistry in all parts of the world, retired five years ago.

VICTOR MEYER.

Victor Meyer, the present director of the laboratory, is probably the most attractive chemical personality in Germany, both for the direction of arbeiten and for his lectures, which are delivered six times a week, at 8 a. m. At the lecture table he is clear and fluent, rapid and orderly in experimentation; and without pausing for emphasis, he gives all the synthetic reactions in unbroken succession, covering the board over and over again with a rich profusion of delineations. Nevertheless, he holds the close attention of the beginners. There are as many chemical students from England and America in Heidelberg as in any two other German universities together.

I visited the Freiberg Mining School, in Saxony, and the analytical laboratory of Fresenius, at Wiesbaden, both of which are well known to chemists. Both these institutions show that important chemical work can be done with simple apparatus on rough tables. At Freiberg there is a considerable American colony.

EXPERIMENTAL WORK BY MANUFACTURERS.

Before closing this cursory account of the laboratories of chemistry in the German empire, I must make mention of the experimental laboratories of the great manufacturing works. These also are places of research in part for publication. I had full opportunities in four of these works: 1, the "Badische Anilin und Soda Fabrik," at Ludwigshafen, with its 4,000 workmen; 2, the Color Works at Hoescht, 3,000 hands; 3, the United Factories of Zimmer & Co., for cinchona alkaloids at Frankfort; and 4, the chemical works of Merck, at Darmstadt. The exhibits of several of these works were included in the great monument of synthetic chemistry, made by German universities, in the educational department at the Chicago Exhibition.

The most appreciative mutual relations exist between the chemical industries of Germany on the one hand and her university chemical laboratories on the other hand. In fact, the liberality of the manufactories is not confined to the universities of their own country, as we have reason to know, having lately received gifts of large collections from two of the works just named, with all charges of transportation paid to Ann Arbor.

In the way of investigation the German universities are of inestimable value to learning. In opportunity for the highest study they are scarcely equaled.

It has been a great privilege to me to see even but a little of the chief laboratories of Europe, and I regret that my means of description do not enable me more fully to share this privilege with my readers.

* The death of Prof. Kruess has been announced since the above was written

THE CHEMISTRY OF THE SIEMENS FURNACE.*

By A. M. DICK and C. S. PADLEY.

IN submitting this short paper on the chemistry of the Siemens furnace it is not our intention to go deeply into detail, but rather to treat the subject in a more or less elementary form, confining ourselves to some of the chief reactions already well known to metallurgists.

The Siemens regenerative furnace is constructed on the open hearth principle, and may have either a basic or an acid lining, but, as basic work is of little moment in Scotland, we confine our remarks to the acid process. Though not coming strictly under the title of this paper, a short description of the furnace may here be introduced with advantage. The combustion chamber, or body of the furnace, from the charging floor level, is constructed of silica bricks, which, from their refractory nature, are capable of withstanding intense heat without softening. This part of the furnace, together with the bottom or hearth, which is also composed of siliceous material, is strongly braced together by suitable binders to resist the expansion, which is considerable, owing to the high temperature employed in the Siemens furnace. The hearth is supported by steel girders, beneath which are the four regenerative chambers, two being for gas and two for air. These regenerative chambers are almost filled with firebricks placed in alternate layers at right angles to each other, sufficient space being left for the free passage of the gas and air, which enter the furnace through suitable inlets, technically termed ports, thorough combustion being obtained by placing the air ports over those provided for the gas. After combustion on the furnace hearth the waste gases, before entering the chimney flue, pass through similar ports and down through the regenerators at the opposite end of the furnace, raising the bricks contained in the latter to a high temperature. By means of suitable valves, at intervals of about thirty minutes, the direction of the current is reversed, and the heat, already stored up in the chequered brickwork, is communicated to the incoming gases. This is, of course, the principle of the regenerative furnace, and the ease with which a great heat may be maintained in the furnace, with a comparatively small expenditure of fuel, has proved of great value to the steel maker. As already stated, the fuel used in the Siemens furnace is gas, and is obtained by the passage of air, or a mixture of air and steam, over a stratum of red hot fuel. The apparatus in which the gas is made is known as the gas producer, and exists in many types and forms. For our present purpose we may classify them as of two types, viz., those which have an open grate and depend on cooling tubes for their draught, and those which are worked with a close grate, and are supplied with air by means of steam blowers, or other means of induced draught. The composition of gas from a steam blown fire varies more than that from the open grate type, but the following may be taken as an average analysis of each:

	Open grate. Per cent.	Steam blown. Per cent.
Carbon dioxide, CO_2	3·0	6·0
Carbon monoxide, CO	29·0	23·0
Hydrogen, H	8·0	18·0
Marsh gas, CH_4	3·0	3·0
Nitrogen, N	57·0	50·0
	100·0	100·0
Combustible volume	40	44

As will be seen from the analysis, the total combustible volume is slightly larger in the steam blown fire, the amount of hydrogen being specially noticeable. The nitrogen is correspondingly lower, but there is generally a higher percentage of carbon dioxide. Perhaps the chief advantage of the steam blown fire lies in the fact that inferior fuel, such as dross, can be used, and that, in shoveling out the ashes, there is comparatively little waste of unburnt char or coke. In the case of open grate producers the gases are conveyed to the main gas culvert by overhead cooling tubes, while those from the more modern close grate type are conveyed through underground brick flues and enter the furnace as already described. The hearth, or bath, of the furnace, on which the charge is worked, is composed of a mixture of a highly refractory and a more fusible sand. This mixture is applied in thin layers, and at the temperature employed becomes sintered into a cohesive mass, sufficiently hard to withstand the necessary amount of wear and tear. Unlike the bottom of a puddling furnace, which forms an active agent in removing the metalloids, carbon and silicon, the hearth or bottom of a Siemens steel furnace (either basic or acid) remains inert, and has no chemical action on the charge. The charge, or material from which the steel is to be made, consists of hematite pig iron and steel scrap, the proportions being largely influenced by the amount of scrap available. A very common practice in this country is to use about 75 per cent. pig and 25 per cent. scrap. A pig and scrap charge, suitable for working in the Siemens furnace, is of the following composition, though manganese varies very much in different brands of iron:

	Hematite Pig.		Steel Scrap.	Initial Charge.	
Carbon (graphite)	3·500	3·750	0 170	2·620	2·850
" (combined)	0·250			0·230	
Silicon		2 200	0·025		1·660
Sulphur		0 043	0·045		0·042
Phosphorus		0·043	0·045		0 042
Manganese		0·500	0·500		0·500
Iron (by difference)		93·464	99·215		94·906
		100·000	100·000		100·000

From these analyses it will be seen that carbon, silicon and manganese play the leading part in the reactions about to be described, it being necessary that these elements be almost totally eliminated before the metal can be described as steel. As there is no reduction of sulphur and phosphorus during the working of the charge, it is imperative that the percentage of these elements, in the initial charge, does not exceed that permissible in the finished steel. A high percentage of silicon in the initial charge retards the working, as a greater quantity of ore is required to effect its oxidation. It is therefore best kept within reasonable bounds, though, as silicon decreases in pig iron, sulphur occasionally shows a tendency to become unreasonably high. In the manufacture of mild steel, the removal of the oxidizable elements is effected by the use of iron ore reasonably free from impurities and preferably of a fairly "lumpy" nature. The well known Somorrostro ore, which has been found very satisfactory, is of the following composition:

Fe_2O_3	77·500
MnO_2	1·500
Al_2O_3	1·200
CaO	4·820
MgO	0·320
SiO_2	5·250
S	trace
P_2O_5	0 032
CO_2	4·280
H_2O (combined)	5·020
	99·922
Metallic iron	54·25

When the charge is thoroughly melted, it is necessary to add iron ore to effect the oxidation of carbon and silicon. The reactions which take place are as follows:

$$Fe_2O_3 + 3\,C = 3\,CO + 2\,Fe.$$
$$2\,Fe_2O_3 + 3\,Si = 3\,SiO_2 + 4\,Fe.$$

The carbon escapes in the form of carbonic oxide gas, and the silicon, which is oxidized to silica, combines with a small quantity of oxide of iron with the formation of a fluid slag. This slag consists mainly of silicate of iron with a large excess of silica and small quantities of manganous and calcic silicates, a usual composition, before adding ferro-manganese, being:

FeO	23·59
MnO	3·82
CaO	4·16
MgO	0·21
SiO_2	68·02
	99·80

The silica and ferrous silicate in the slag are derived from three sources: (1) From the oxidation of the silica in the charge; (2) from the silica originally contained in the ore; (3) from the wear and tear of the furnace bottom. This slag, though of no commercial value, fulfills a useful function in protecting the metallic iron of the charge from the oxidizing effects of the furnace atmosphere, and subsequently prevents the metal in the ladle from chilling during casting. The operation in the furnace may be divided into four stages:

1. Melting. 2. Going on boil. 3. Boiling. 4. Steel.

The accompanying table will show at a glance the changes which take place.

	Melted.	Going on boil.		Boiling.			Steel.	
	1	2	3	4	5	6	7	8
Carbon	3·19	3·19	3·18	2·83	1 51	0·53	0·20	0·14
Silicon.	2·25	2·0	1·5	1·09	0·046	0·035	0·03	0 03
Manganese.	0·30	0·25	0·21	0·14	0·09	trc	trc	trc

Sample No. 1 was got immediately the charge was melted, and the subsequent samples at intervals of one hour afterward. In actual practice, a sample drawn from the bath immediately on becoming molten was of the composition shown in column No. 1 of the above table. This represents the composition of the charge. In order to make the reactions more distinct, we selected a charge in which only 10 per cent. of scrap was used, hence the carbon and silicon are slightly higher than those in the ideal charge already given. This circumstance in no way impairs the usefulness of the table. Columns Nos. 2 and 3 represent the second, or "going on boil" stage. Though a certain amount of ore has been added, the bath has, up to this point, remained comparatively quiescent. It is evident, however, from the decrease of silicon and manganese, that some work has already been accomplished. It will be noticed that the carbon has not been similarly affected, because, at this stage, the affinity of silicon and manganese for oxygen is greater than that of carbon. In the third, or "boiling" stage the surface of the bath presents an aspect of brisk ebullition; carbon monoxide is freely evolved from all parts, and can be seen burning with its characteristic blue flame. The changes during boiling are shown in columns 4, 5 and 6. We find that the silicon has been

* A paper read before the West of Scotland Iron and Steel Institute and published in the Colliery Guardian.

greatly reduced, the manganese has almost disappeared, and the carbon is being vigorously attacked. At the end of this stage, the metal is ready for being tapped, if required, for such purposes as hard wire, rails, hard billets, etc. If required for boiler plate, ship plate, or other mild quality, the operation will take some two hours longer. As the charge under notice was intended for mild steel, we had the opportunity of getting two more samples at further intervals of one hour, and these bring us to the last two columns of our table. The only alteration now is in carbon, which becomes difficult of removal when the amount sinks so low as 0·20 per cent. or under. During the foregoing somewhat protracted process, large quantities of gases, principally carbon monoxide and hydrogen, are absorbed by the fluid metal, while a certain amount of oxide of iron becomes diffused through it. If these are in excess, the metal becomes what is technically termed "wild." This condition is brought about chiefly by too rapid additions of ore, and by adding more ore than is necessary to oxidize the carbon in the molten metal, resulting in the formation of a slag containing too much free oxygen. Metal of this kind emits large quantities of gases during solidification after casting, and causes the ingots to be honeycombed or spongy. Ingots of this description will neither hammer nor roll well. Even with the most careful working this difficulty must be expected to a certain extent, but can be partly overcome by the addition of ferro-manganese either before tapping or while the metal is running into the ladle. Ferro-manganese, as its name implies, is an alloy of iron and manganese rich in carbon, the analysis of the high quality, now generally used, being:

C	6·00
Si	0·52
S	trace
P	0·26
Mn	80·00
Fe (by difference)	13·22
	100·00

The chemical action of the manganese, of which the alloy is mainly composed, consists in the reduction and removal of diffused oxides, metallic iron being formed and manganous oxide, which, being readily fusible, easily finds its way to the surface of the molten metal. To insure a good product, a sufficient excess of ferro-manganese should be added, the amount of manganese remaining in the finished steel being rarely under 0·40 per cent. In this connection the use of ferro-silicon (an alloy of iron, manganese and silicon) is also effective. By its employment a metal may be obtained which gives off considerably less gas on solidification, the ingots obtained being free from honeycomb, and require no sanding or wedging down. For certain purposes, such as in the manufacture of steel castings, this is an invaluable material for the steelmaker. Now, having roughly traced the manufacture of steel from the initial stage to the form of ingots, we take leave of the subject, the subsequent operations being purely mechanical and having no connection with the chemistry of the Siemens furnace.

THE DRAWING OF LOTS IN CONNECTION WITH THE REDEMPTION OF THE BONDS OF PARIS.

THE drawing of lots in connection with the redemption of the bonds of the city of Paris, payable with prizes or reimbursable at par, is done in public. The dates of it are announced by official notices. It takes place in the hall of the Palace of Industry.

All the loans, except those of 1855–1860, allow of four annual drawings. The operation of drawing begins at ten o'clock in the morning sharp.

The members of the commission (a counselor of prefecture, representing the prefect of the Seine, and four or five members of the Municipal Council) sit around a table covered with green baize placed upon a stage at the rear of the hall. The representatives of the newspapers have places reserved for them.

In the part of the hall preceding the stage are situated to the right and left the closets that contain the wheels of the municipal loans of 1855, 1860, 1865, 1869, 1871, 1875, 1876, 1886 and 1892. At a table are seated the male and female employes who are presently to take the lucky numbers from the cases.

In the second part of the hall, separated from the first by a wooden railing, stands the public. The physiognomies are almost always the same. There are types of avaricious women, with ears wide open to the calling of the numbers, and who leave with the appearance of people who have been robbed when their numbers have not been drawn; then there are small stockholders who, for one morning, have modified the itinerary of their daily promenade, and in winter there are a few laborers out of work who know that there is a stove always roaring.

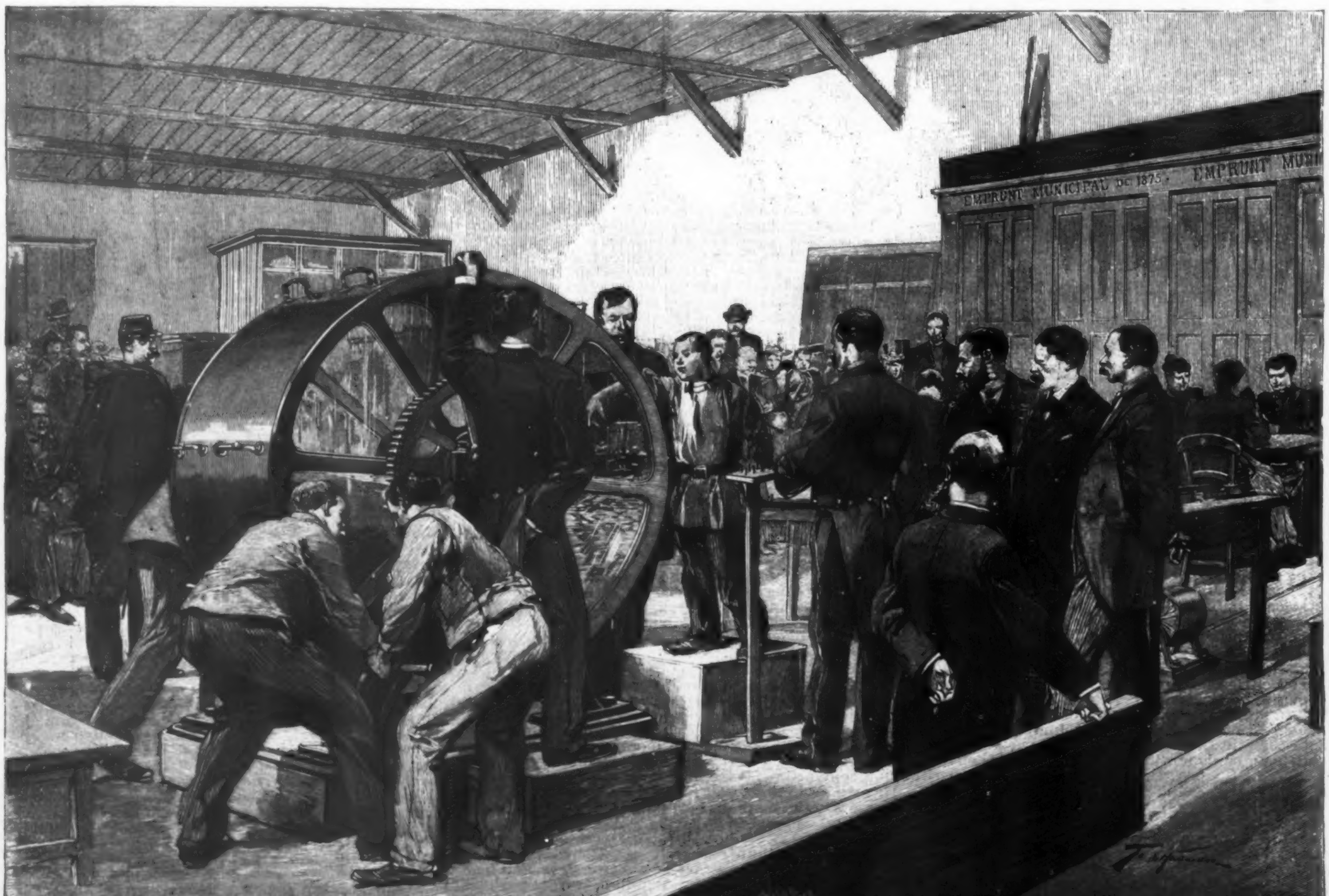
Shortly before the beginning of the operation laborers draw the wheel of fortune out of the closet in which it is inclosed. It slides upon rails to the center of the hall and one proceeds to put it in shape.

The cylinder, the convex surface of which is of copper, has two of its sides closed by double and transparent plates of glass, thus permitting the interior of the wheel to be seen. The latter is provided with iron pyramids and cones in order to facilitate the mixing up of the numbers. In the cylinder there is an aperture which is closed by a small copper door provided with three locks. The key of one of these is placed in the hands of the president of the commission. The two other keys are kept by municipal councilors chosen by lot.

The cases in which the numbers are rolled consist of two small copper cylinders, one sliding in the other and held firmly in place so that the case cannot open easily. The numbers of the bonds are printed upon strong paper. Protected by the cases, they are capable of lasting a century at least without undergoing the least deterioration. It is well that this is so, since the last loans raised by the city are payable in forty-eight years.

At the hour fixed the president of the commission opens the session by announcing how many numbers are to be drawn from the wheel, and, in the order of their extraction, the prizes that they will win. Then, in the presence of his colleagues and the public, he

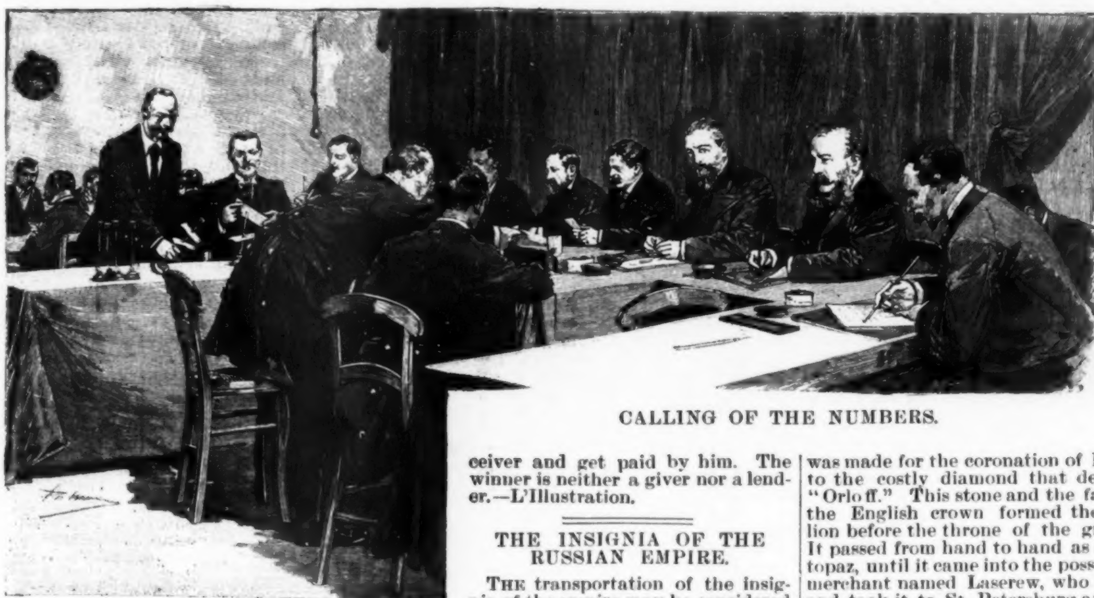
OPENING THE CASES THAT CONTAIN THE NUMBERS.



DRAWING THE PRIZES ON THE BONDS OF PARIS.

breaks the seals placed upon the keyholes of the three locks. At the close of each drawing, in fact, wax seals are applied to these locks, so that no one can tamper with them under any pretext.

The wheel is set in motion by workmen, and the operation begins. Ill tempered people sometimes complain that the wheel is not revolved a sufficient number of times! It is not very long ago that one of them even wrote to the prefect upon this subject, and a circumstantiated report was furnished in answer to the complainant!



CALLING OF THE NUMBERS.

By a contrast that affords subject for philosophic reflections, it is some of the outcasts of this world—children that are assisted by the department of the Seine—that draw the happiness of a few persons from this wheel. The administration inscribes ten francs in their savings bank book as a present. It is very rarely that the winners add to this modest sum. Perhaps they are not backward because of a want of generosity, but through ignorance. How much do they know as to what hand they owe their wealth? Very little, assuredly. These children, with the sleeve of their blue blouse rolled up above the elbow, thrust their arm into the heap of cases. One of the latter, having been taken out, is carried in a glass cup to the president of the bureau, who opens it, proclaims the number and passes it to a municipal councilor, who rereads it in a loud voice. The same is done with the twenty-one first prize numbers. The numbers of the bonds redeemable at par are afterward extracted, but as the number is usually large, the commission does not read them. Such reading would sometimes take five or six hours.

In order that the drawing may be effected without any possible error, the cases extracted are placed by children upon square boards, each containing twenty-five apertures. The employe near the wheel registers every hundred cases drawn.

Then these cases are opened by male and female employes by means of special pincers. The unrolled numbers are placed to the number of twenty-five upon needles. They are afterward pasted upon cardboard in an adjoining room so as to permit of a rapid classification. An official report of the operation is signed by the members of the commission, and the lists of the drawing are immediately affixed to the inner door of the hall, there to remain until they shall be published.

After the last number has been extracted from the wheel, the door of the latter is locked and sealed.

These operations, it will be understood, must be conducted with much care and precision. Not a single number must be missing. At the last drawing of the bonds of a loan all the numbers not relating to prizes must be in the wheel. The absence of a single one would expose the city to interest damages.

Apropos of this it is said that fifty years ago there was a number missing in the last drawing of a loan effected in 1832. The owner of the bond, whose number was not in the wheel, demanded an indemnity of 100,000 francs, equal to the prize that he might have won.

The tribunal before which the case was called judged the claim excessive, but since the administrative negligence was apparent, the plaintiff was allowed 3,000 francs.

As we have said, the persons present at a drawing are few in number. So it rarely happens that a winner makes himself known during the course of the operation. Once to our knowledge one of the spectators heard called two of the numbers carried upon his list. One of them won 50,000 and the other 10,000 francs. But he was far from feeling happy over it, for he had sold his shares two or three days previously. It was at a drawing of the loan of 1871 which, a little different from the others, comprised two operations. The first consisted in drawing by series the bonds that would compete at the final drawing. During these two operations there is generally an interval of ten days, during which the bonds called upon to participate in the second command a premium at the Bourse. In order to realize a gain of a few louis our man had sold his.

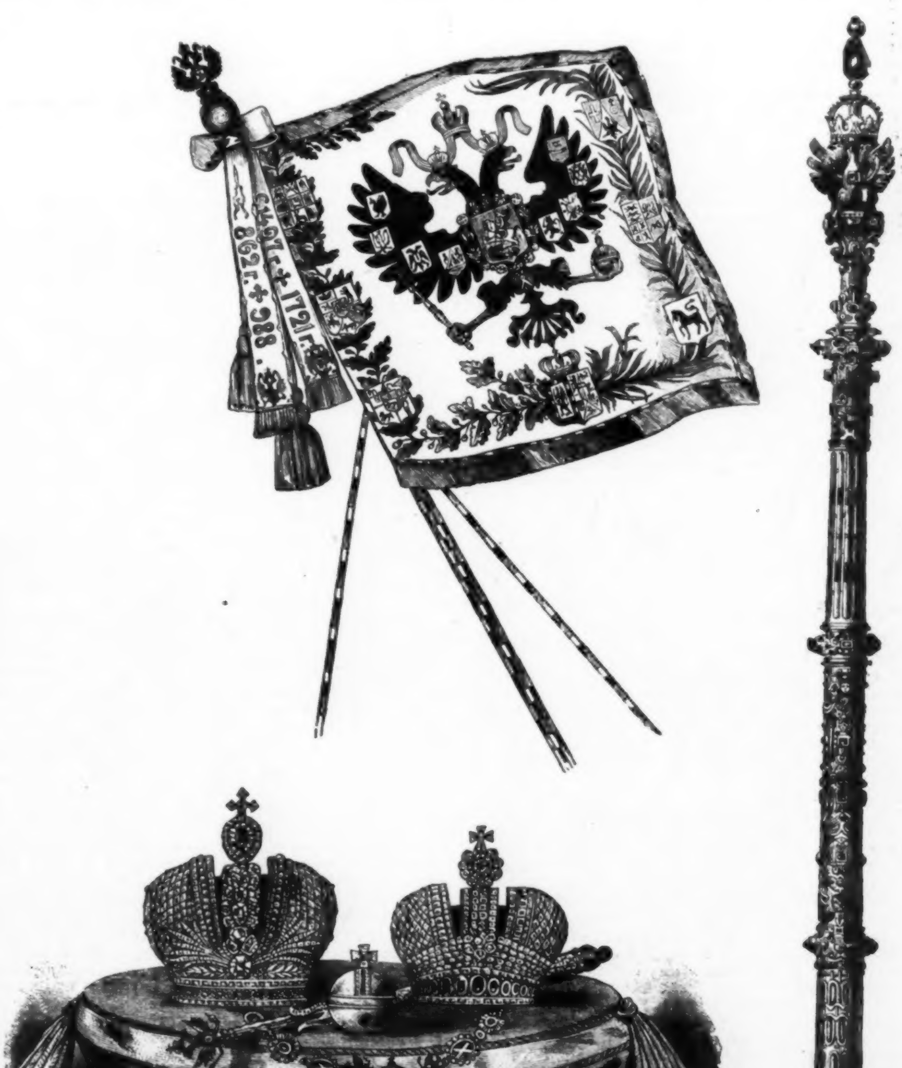
The prizes are paid at the city cash office upon the simple presentation of the bond after the drawing without any formality, the shares being payable to bearer.

Up to 1891 three per cent. (state tax) was held back upon the total amount of the prize, deduction being made of the price of the bond at par. Since June 1, 1891, the rate of this tax has been raised to four per cent.

Who, during the last twenty or twenty-five years, have been the winners of the first prizes of the city of Paris? What has become of them? It would be impossible to find out. For fear of being overwhelmed with demands for aid, with propositions from inventors and with solicitations of all sorts, those favored by fortune preserve an incognito as far as possible. Those who do not employ a banking house as an intermedium address themselves directly to the municipal receiver and get paid by him. The winner is neither a giver nor a lender.—L'Illustration.

THE INSIGNIA OF THE RUSSIAN EMPIRE.

THE transportation of the insignia of the empire may be considered the beginning of the ceremonies connected with the coronation. These emblems of sovereignty were moved in a golden carriage from the Winter Palace in St. Petersburg, where they had been kept, to the Kaiser Nikolaus Station, and from there were taken to Moscow in a special train in charge of high officials and a military escort. The insignia of Russia, like that of all the European monarchies, consists of a crown, scepter and mound, besides the banner of the empire. The crown for the Czar is worth more than 1,100,000 rubles ($614,900). It is formed of two halves, symbolical of the eastern and western Roman empires, between which is a band, and from the latter rises a cross consisting of five diamonds. With the exception of the ruby which forms the central ornament, only diamonds and pearls are used in the decoration of the crown, which Empress Catherine II had made for herself by her court jeweler. The crown for the present empress is similar but considerably smaller. The great value of the scepter, which was made for the coronation of Emperor Paul, is due to the costly diamond that decorates its point, the "Orloff." This stone and the famous "Kohinoor" in the English crown formed the eyes of the golden lion before the throne of the great Mogul at Delhi. It passed from hand to hand as a piece of glass or a topaz, until it came into the possession of an Armenian merchant named Laserew, who recognized its worth and took it to St. Petersburg at the risk of his life, where he offered it to Empress Catherine. The empress considered the precious stone, which was then in a rough state, too expensive, and Laserew took it to Amsterdam, the center of the diamond trade. There, Count Alexis Orlow bought it for 450,000 rubles ($251,550), had it cut and then laid it at the feet of Empress Catherine. At the same time he obtained for Laserew a patent of nobility and an annuity of 2,000 rubles ($1,100). The "Orloff" weighs $199\frac{3}{4}$ carats, or $8\frac{1}{4}$ carats more than the "Kohinoor." The mound was also prepared for the coronation of



INSIGNIA OF THE RUSSIAN EMPIRE.

Emperor Paul. It is of gold, with a girdle of three rows of brilliants, in the center of which is a beautiful almond shaped diamond. A similar band passes over the top, in which there is a large sapphire that carries a cross of diamonds.

The central field of the banner shows the two headed black eagle holding the scepter and the mound in its claws. Above the heads that are decorated with diamond crowns there is a large imperial crown from which two blue bands float on the air. On the breast of the eagle we see a gilt edged red shield bearing a representation of St. George in a silver armor and blue mantle, and mounted on a silver steed; with his sword he is piercing a golden, green winged dragon. Around the shield is hung the chain with the cross of St. Andrew, a larger model of which rests on the cushion with the crowns. On each wing of the eagle are four coats of arms of the different parts of the empire, and similar coats of arms connected by branches of laurel and oak form the border of the banner.—Ueber Land und Meer.

SOME MARINERS' MYTHS.

MODERN civilization brings with it greater knowledge and tends to rapidly dissipate all those superstitions which at one time were believed to be effectual methods of evading one's destiny or of influencing the forces of nature by means of charms or ceremonies. Few sailors to-day have any serious belief in their efficacy, and such as have are probably biased by tradition more than faith, and are disposed to cling to their outward manifestations as remnants of an immemorial custom which they are unwilling to relinquish. So far back as the pages of history are open to us, sailors have ever been deemed, justly or unjustly, the most superstitious of any class in the community. Superstitious they certainly are, but it is not quite clear why they should be more superstitious than other people, but it probably follows from the fact that they have constantly to deal with the forces of nature and are more exposed to the fury of winds, waves, and other natural phenomena whose movements were not in the old days, and in many respects are not now, reduced to scientific laws. Just as we see well educated people, the victims of some terrible malady, on finding that orthodox remedies are powerless to alleviate pain, turn aside to experiment with any highly advertised quackery, so sailors of bygone years, exposed to the fury of wintry gales in ships of less size than a man-of-war's launch, may well have listened to the promises of weather wizards. No matter that dozens fulfilled every detail of the imposed fetish—including the inevitable fee to the instructor—and were in spite of it overwhelmed in calamity; this would not affect the simple faith of the individual that his good luck was the direct effect and sequence of his charm. As might have been expected, a large number of mariners' myths have come to us from the hardy men of Norway, others from the days of Rome and Greece, and others again are lost in the mists of antiquity. We read of Sennacherib offering up his oblations of a golden fish and a golden bowl to propitiate the deities before some adventure on the Tigris, and in later times there was a Grecian fleet detained because the omens were unfavorable; still more recently there are the ceremonies of the "Wedding of the Adriatic," and the offerings presented by French fishermen for safety and luck. The magnificent pageant of blessing the Adriatic and casting a ring into its waters is world famous. It was performed by the Doge each Ascension Day, as a thank offering for a great naval victory won by Venice over the Saracens. Pope Alexander gave the first ring in 1174. Flowers were also strewed on the sea, and a barrel of holy water emptied into it.

As an instance of antiquity take the expression in every one's mouth of a "capful of wind." The origin of this phrase can be traced to a Norse king, Eric VI, who died in 907 A.D. He was credited with the useful power of directing the wind to blow where he wished by the simple method of turning his cap to that point of the compass. His powers were much appreciated and trusted and resulted in his being known as "windy cap." There is no evidence as to whether he could regulate the force of the wind as well as the direction; presumably he could or his faithful believers would not have been so many. A "bagful of wind" is another common expression and indicates something like a gale. This has been traced down to the classical legend of Æolus and his captive winds confined in bags. To him is also attributed the invention of sails and a deep knowledge of astronomy.

On account of the violence of winds, too, many a mariner finds his last rest in Davy Jones' locker. These words are of peculiar interest to mariners and also to philologists, for they show the influence of many languages on a word descended from a remote date, and they also show the influence of Bible history on tradition. The word "Davy" could easily be made the subject of a learned essay, but it is sufficient to say that it is a corrupt and degenerate descendant of Divus—Latin for God. After many changes it became Deva, a term signifying a demon, and then by variation it became converted into the English word devil, with a meaning of a malevolent deity presiding over the waters, and finally in sailor phrase became generally known as "Davy." "Jones" has no particular reference to Wales, but owes its origin to the Biblical character, Jonah, and his unfortunate experience in the fish's belly. Whether or not the connection of Jones and Wales can be traced to that of Jonah and whales is a matter for philologists and historians. By a simple transference of thought, the abode of Jonah in the belly of a sea monster became the origin of the sea itself being regarded as Davy Jones' locker. The malevolent influence of Davy Jones over the deep sea is noticed by Smollett and numerous other writers.

The evil deity is also known by another title—that of Old Nick. At the present time this is not an unfrequent euphemism among landsmen, but it was some years ago common enough among sailors, and especially those hailing from Devonshire ports. The reason for this is far from clear, for the word can be distinctly traced back to its Norwegian origin, and although the word is known in the Shetlands and used there amongst folks of Norse descent, there is nothing to suggest a reason for its special use in Devonshire. Nick of to-day was Nicor in Anglo-Saxon, and in Norse appeared as HNICKAR, and was one of the 12 names of Odin, the paramount god.

The ancient and honorable ceremonial of prayers and decoration upon the launch of an important ship is another survival of an old custom in a modern dress. The old Greeks had much the same formalities as regards flowers and the baptism of wine, and an elaborate service was performed to propitiate the appropriate deities. It was always regarded, and still is, that a loss of life on the occasion foreboded ill for the vessel's future. Consequently, the Greeks used their worst slaves for the duty of knocking away the last shores, hoping that their sacrifice would not detract so much, either from their pockets or the career of the ship. In modern times, it will be remembered how persistently misfortune dogged the s. s. Rose, which turned turtle on being launched on the Clyde some twelve years ago. Again, to take a parallel from the land, we may remember in this connection the prophecies of the anti-railway party when Huskisson was killed by a locomotive at an opening ceremony. Sometimes, however, executions were inflicted by the criminal being crushed under a vessel's hull, and "roller reddening" was looked upon as propitiatory.

The frequency of the act and the general adoption of steam propulsion have done much to abolish the well known ceremony of "crossing the line." This appears to be a comparatively modern affair, and an authority on the subject quoted by Capt. Basset, of the United States navy, who has written an interesting book on the legends and superstitions of the sea, ascribes it to the rejection by the Reformers of the custom of baptism of ships as practiced by Roman Catholics. The idea appears to have been to redeem all persons who had not before crossed the line. At one time apprentices were cast from the yard arm and fished out in a somewhat promiscuous manner, and afterward the custom was to throw water from a barrel over them. Probably the dramatic addition of the boarding by Neptune, and the rest of it, was the result of a desire in the sailing ship days to get up a little excitement. It was always possible to buy redemption from treatment by means of money or wine. At one time it was customary, if the captain refused to allow Neptune to board the ship, to knock away part of the bows or figure head. A somewhat analogous custom to this one of "crossing the line" has been known among Newfoundland fisherfolks upon their visiting some new spot, and it has also been practiced by mariners upon crossing the Arctic Circle.

The old superstition as to lucky and unlucky days has also largely passed away. Foreign mails start and arrive on Fridays without any regard for beliefs which were at one time accepted as beyond argument by most sailors. Some thought otherwise, as will appear later. Generally speaking, all saints' days and church holidays were regarded as unlucky, and certain days in each month were rather distrusted. In an old almanac of 1615 we find that July 19, 20, 24 and 31 were noted as "no good anchorage." Sunday was always looked upon as lucky, presumably in reliance on the maxim "The better the day, the better the deed," and the fact of our Lord's resurrection having taken place on that day. Monday had no particular reputation for good or evil; Tuesday was the same, except among Spaniards, who said "Don't marry or go to sea or leave your wife" on that day. Wednesday was the day of Odin, the Norse god before mentioned, and lucky; Thursday was named after Thor, the Norse god of war, and was auspicious. Friday was the day dedicated to Freya, Norse goddess of love, and having reference to women, was not liked on this ground. The true reason for avoiding Friday was of course the fact of the crucifixion having taken place on that day, and sentiments of special veneration for the day became converted into a feeling of fear for the results which would follow its violation. The Spaniards, on the other hand, had a considerable veneration for Friday, and believed that some occult influence enabled Columbus to successfully clear out of port and discover new land on that day. Saturday was generally considered auspicious.

Sailors had great veneration for odd numbers, a belief still obtaining in the number of guns fired for salutes. Sneezing to the left was a serious matter, though a sneeze to the right was not so bad. Themistocles once detained his ships on account of the bad luck that he feared would follow a sneeze. The Shetlanders were particularly sensitive on the point. In Germany to this day it is customary to say "Prosit" as a salute after a friend sneezes, and in France they use a similar expression, "Votre santé."

It is natural that such a startling phenomenon as the appearance of luminous bodies among the rigging should have made a deep impression upon the minds of sailors. St. Elmo's fire, to use the best known title for these appearances, has been looked upon from classical days as a portent of the first rank. We read that Orpheus prayed that the argonauts might have success and safety, and that a mysterious effulgence encircled the heads of Castor and Pollux, who were on board with him. They were reputed to be the sons of Jove, and this illumination was therefore looked upon as a direct sign that the prayer had been heard. This doubtless is the parent of the mariners' belief that two or more balls of light are auspicious, while, on the other hand, one such ball is a portent of evil. So far as we can gather, the last named legend is due to the belief that the spirit of these heroes' sister, Helen of Troy, had boarded the vessel and that she would bring disasters to the ship as she brought them to her fellow citizens. Consequently, the single light is widely known under the title of St. Helena's Light. It is curious to observe also that the meanings of the names of these divinities should bear out these views. Castor signifies "Adorner," Pollux, "Lightful," and Helena is another form of Selene, the Greek for "Moon." As is well known, both adornment and light are outward manifestations of inward joy and festivity, while the moon has ever been regarded as fraught with disaster; hence the term moon struck and lunatic. The troubles brought about by the pranks of Ariel will be in the minds of those familiar with Shakespeare's "Tempest;" and, again, Macaulay sings:

"Safe comes the ship to haven,
Through billows and through gales,
If once the great twin brethren
Sit shining on the sails."

On the other hand, Longfellow, in the "Golden Legend," makes the Padrone fear bad weather after seeing these phenomena:

"Last night I saw St. Elmo's stars
With their glittering lanterns, all at play
On the tops of the masts and the tips of the spars,
And I knew we should have foul weather to-day."

The French sailors had a more scientific belief for the good effects following two or more balls of fire and the evil effects attending one. They imagined that when a tempest was brewing, the electric matter got compressed and packed as did clouds, and therefore when it revealed its presence at all, it did so as one mass; but that when the storm was passing away, the matter was diffuse and appeared consequently in several places. They also believed, as a variation on the above, that the flames on the yards were the visible presence of the spirits of dead sailors who would help them at their work, but when the apparitions appeared upon the hull it indicated that those on board would soon join them. The term St. Elmo is variously ascribed to Helena, mentioned before, or to Ermo or Elmo, the Italianized form of the name of the great Syrian bishop and martyr, Erasmus, who lived in the third century. It is also designated Saint Elias, Saint Clara, Saint Nicolas, and on the Suffolk seaboard (and, we believe, in Spain) is sometimes called "Composant." This is a corruption of "corpus sanctum," and is due to yet another belief, viz., that it is an emanation from the body of Christ.

There are some extraordinary myths respecting the power of wind raising. The origin of the belief in the efficacy of whistling is unknown, but the belief itself has been widespread, held as it has been in Greenland, India, China, Sweden, and Europe generally. We come across it repeatedly in literature. Longfellow says in his "Golden Legend:"

"Only a little hour ago
I was whistling to Saint Antonio
For a capful of wind to fill our sail,
And instead of a breeze he has sent a gale."

The third line may be incidentally noticed as illustrating the word "capful," touched upon above. It is often said that care must be taken to whistle at the right moment. If it be done in a calm, a pleasant breeze will come, but if it be done when there is already wind, the effect will be to enrage the devil (whose influence over the sea has already been noted), and to arouse a hurricane. "Whistles rash bid tempests roar," says Sir Walter Scott in "Rokeby."

Another sure way of incurring disastrous gales is to carry a cat aboard. Hares are also thought to be harbingers of trouble. There is a curious amount of collateral evidence to show how sailors objected to cats. The reason why is not clear, but it is certain that they were hated, and their name has been given to those things to which seamen greatly objected. Maneuvers with the anchor are arduous, and it may be for this reason that parts of the tackle employed are termed cat head, cat hook, cat fall, and cat tail. Weak tea is nasty and is known as cat lap; a short sleep is unsatisfactory, and is called a cat nap; a breath of wind insufficient to move a vessel is a cat's paw; a greater amount of breeze is a cat's skin. We also speak of its raining cats and dogs; and finally we come to that most dreaded instrument, the cat-o'-nine-tails. Probably the vulgar expressions of "catting" and "shooting the cat" are traceable to this inspiration. Some readers may remember an old song which ascribed many evils to one reason—"It was the cat." We have the lodging house cat, too, as a variety. So it is clear from the above that the sailor's apprehension of the evil-producing power of poor pussy has spread itself over many of his surroundings. It may be also mentioned that the Egyptian goddess of evil was a cat headed figure.

Their extreme sensitiveness to weather, coupled with their mysterious presence many miles from land and their supposed communion with angels, are doubtless the causes of the attention paid to certain sea birds, and the prophecies of a fair or foul future founded upon their movements. Mother Carey's chicken may be taken as an example of a bird whose attendance upon a ship is never passed by without notice. The superstitious reverence for it is plainly due to its name, which is a corruption of a title of the Virgin—Mater Cara. Its other name of petrel is an Italian diminutive for Peter, and bears witness to the belief of that nation that they represent St. Peter walking upon the sea. Their supposed character of harbingers of storm is exemplified in their other name, Procellaria. Gulls also are supposed to foretell bad weather with unerring accuracy, and their presence on sea or land makes the difference between expecting fair and foul winds. They certainly acted up to their reputation during the great frost of January, 1895, for they traveled for many miles up the Thames before the cold began, and twenty-four hours before it ceased they began to fly seaward again. The albatross was generally regarded as a bird of good omen. In the "Ancient Mariner" some telling lines reveal the evil effects of killing one of these noble creatures, though the sailors there afterward recant and state that it was right to kill a bird which had brought them fog and mist. The bird of all others which is said to portend calm weather is the kingfisher, and the expression "halcyon days" has passed into a common phrase. The legend is that the kingfisher, or halcyon, as it was once called, used to lay its eggs in nests that floated on the sea about the winter solstice, and that the bird had the power of charming the winds and waves into a calm during the hatching season. Thus Dryden says:

"Then came the halcyon, whom the sea obeys
When she her nest upon the water lays."

And, again:

"Amidst our arms as quiet you shall be
As halcyon brooding on a winter's sea."

The phantom ship is yet another myth of universal acceptance. The origin may safely be placed to the phenomenon of mirage, exaggerated by fear and repetition—most potent sources of error. The best known of many legends is that connected with the "Flying Dutchman." It appears substantially the same under many foreign dresses, but the account of M. Jal is generally taken as the standard. A wicked Dutch

skipper was trying to round the Horn against a tempestuous head wind. His men were half killed with work, but he swore he would sail on until successful, and proceeded to throw overboard sailors who refused to obey his orders. The Holy Ghost appeared on board as a flaming fire (query, "composant"), and the skipper shot at the vision with his pistol, but the bullet penetrated his hand and paralyzed his arm. He then cursed God and was condemned to sail forever, always on watch, with gall to drink and red hot iron to eat. Marryat tells the tale rather differently, but the legend is substantially the same wherever told or credited. The Cornish fishermen were very superstitious, and their lonely coasts were the birthplace of many legends. They have frequently claimed to have seen Vanderdecken and his phantom ship, a vision surely presaging some disaster. As was said before, the origin of the fable may be safely ascribed to mirage, which phenomenon might well be the basis of the apparition of a specter ship, such as described in the "Ancient Mariner:"

> "Without a breeze, without a tide,
> She steadies with upright keel."

These are but a few of many such legends; it is possible to mention many others, such as the belief that a ship's bell will toll when she sinks, however firmly lashed. There are legends also as to the tampering with bell buoys, and Southey's poem of the Inchcape Rock comes into the mind at once. There it will be remembered that the Abbot of Aberbrothok had placed a bell on the rock which Ralph the Rover had cut off and sunk in a mischievous mood. Coming back, after a long voyage, to Scotland, he meets with fog, and wishes he could hear the bell of the Inchcape Rock, which he knows is close at hand. Nemesis pounces on him for

> "The vessel strikes with a shivering shock.
> O Christ! it is the Inchcape Rock!
>
> "Sir Ralph the Rover tore his hair,
> He cursed himself in his despair;
> The waves rush in on every side,
> The ship is sinking beneath the tide.
>
> "But even in his dying fear
> One dreadful sound could the Rover hear,
> A sound as if with the Inchcape bell
> The devil below was ringing his knell."

Hundreds of romances of haunted cliffs, witches, ocean paradises, ghosts on board, and so forth, might be told. They are all of interest, and some are based on foundations analogous to those noticed in this article. It is curious to find that in every quarter of the globe legends of similar characters are told and handed down from father to son; such a fact speaks to the innate love of mystery which is the common property of humanity. Many of the myths are of little importance and need not be touched upon in the limited space of an article, but the foregoing are of interest to all nautical men, being traditions handed down from generation to generation, each modifying their titles, formalities and circumstances. We are apt to smile at such things now and plume ourselves on superior wisdom, but a belief in signs such as these has seldom made a man a worse seaman, and has very often had a most useful influence upon the conduct of unruly sailors.—Nautical Magazine.

THE MEASUREMENT OF HIGH TEMPERATURES.

GREAT progress has been made in recent years in the art of measuring high temperatures, and it is not without interest to go back to the origin of such measurements before speaking of the most recent improvements.

(1) Expansion of Solids.—The expansion of solids was first taken advantage of for the measurement of high temperatures, and, after the lever pyrometer, there was devised the Wedgwood apparatus, based upon the shrinkage that clay undergoes under the action of heat, and serving to estimate the temperature of porcelain kilns. It is hardly necessary to say that such apparatus, which are adequate in certain cases, are capable of giving only approximate measurements, that in view of the feeble expansion of metals it would require (in case of the lever pyrometer, and even after amplification) very great length of bars to render the results appreciable, and, finally, that the proximity of the source of heat would interfere with the operation of the amplifying apparatus. Recourse has also been had to pyrometers based upon the difference of expansion of several metals (those called Gauntlett pyrometers). Three copper rods, with an iron rod in the center, are connected with each other and act through the variations of temperature upon the needle of a graduated dial (Fig. 1). In order that such apparatus may operate well, they must be exposed to the heat source as far as to the cone that connects them with the tube that carries the dial. In order to note the number of degrees, it is necessary to wait until the internal tube has reached the same temperature as the external one. With these instruments, a temperature of no more than 600° C. can be exceeded.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 1.—The Gauntlett Pyrometer. FIG. 2.—Metallic Dial Thermometer, with Capillary Spiral Spring. FIG. 3.—Mercury Thermometer.

Indicators that are good up to 500° C. are the metallic thermometers with dial and capillary spiral spring. A steel mercury reservoir is connected through a very small aperture with a capillary spiral spring. If the temperature rises, the spring relaxes through the effect of the increase of pressure of the mercury, and a needle notes the motions upon a divided dial (Fig. 2). These two kinds of apparatus have to be corrected quite often. To this effect, they are immersed either in boiling water or oil or in other baths of known temperature, and care is taken to see that the needle, upon coming to rest, is exactly opposite the proper number.

Upon the whole, it is well to recall that metallic indicators, although they give figures that are adequate in many cases, cannot be employed for precise measurements. In fact, they do not give results that are comparable with each other, since the metals submitted to alternations of expansion and contraction undergo modifications of such a nature as to change their properties.

(2) Expansion of Liquids.—As mercury may be obtained in a very pure state, as its point of congelation (−40°) is remote from its point of ebullition (+360°), and as it is a good conductor of heat, it is to mercury thermometers that recourse is had practically for ordinary temperatures up to about 300°. At this moment, the vapors emitted begin to have an influence upon the figures obtained; but it is possible, nevertheless, to retard the point of ebullition to about 550°. To this effect, the empty space above the mercury is filled either with nitrogen under pressure or with liquid carbonic acid. The glass employed is submitted to a special annealing and is placed in a brass tube provided with a longitudinal glass window through which the degrees may be read. Finally the cistern of the thermometer is provided with a protecting jacket of metal, which is put in connection with the receptacles containing the hot liquids or gases (Fig. 3).

(3) Expansion of Gases.—In order to measure slight variations in temperature, it was natural to think of gases, which are much more expansible than solids or liquids. Among the gases, that which most naturally presents itself to the mind is air. The air thermometer in fact is the instrument that serves as a term of comparison with others below 1,300°. Beyond this point, where porcelain softens, the variation of the specific heat of platinum is taken for defining the temperature.

Apropos of this, we believe it of interest to give the figures employed in the graduation of a pyrometer independently of the boiling point of water:

Ebullition of mercury	358	degrees.
Fusion of zinc	433	"
Ebullition of sulphur	448	"
" " zinc	930	"
Fusion " silver	945	"
" " gold	1,045	"
" " copper	1,054	"
" " palladium	1,500	"
" " platinum	1,775	"

The Wiborgh thermometer is based upon the following principle: A volume, V, of air contained in a porcelain balloon that communicates with the atmosphere through a capillary tube is submitted to the source of heat whose temperature, T, is sought. The communication with the atmosphere is then cut off, and a new volume, V', at the same pressure, but at a temperature, t, is passed into the balloon containing a volume, V, of air at the atmospheric pressure, H, and at a temperature, T. There results an increase of pressure, h, and we have finally in the balloon a volume, V, at a temperature, T, and at a pressure, H + h.

We can therefore write:

$$\frac{V(H+h)}{1+\alpha T} = \frac{VH}{1+\alpha T} + \frac{V'H}{1+at}$$

whence we deduce the value of T:

$$T = \frac{1}{V'H}\left(\frac{Vh - V'H}{a} + hVt\right)$$

The increases of pressure are read upon a Bourdon gage.

In our opinion, the air thermometer method gives excellent results when the measurements are made by a skillful experimenter. It must be said that in practice it is capable of giving rise to gross errors if the necessary precautions are in the least neglected.

Air pyrometers have been employed in the industries, especially for ascertaining the temperature of porcelain kilns. The principle is always the same. Inside, there is placed a small platinum or porcelain reservoir filled with air and communicating with a metal pressure gage through a narrow tube. The temperature at every instant will be proportional to the pressure of the gas. Unfortunately, platinum is permeable to gas. If we place a balloon of platinum in a furnace that contains hydrogen in particular, it will be impossible to admit that the volume of air remains constant. So, too, porcelain seems to be permeable to steam.

The Seyferth system of thalpotasimeters constructed by the Schaeffer & Budenberg establishment is based upon the fact that as the tension of saturated vapors, water or other liquids, possesses a definite value at the different temperatures of such liquids, and that, on another hand, the temperature of a liquid confined in a closed vessel corresponds to that of the medium into which it is plunged, it will suffice to read such tension upon a pressure gage in order to deduce the temperature therefrom. The mercury thalpotasimeter is capable of indicating temperatures up to 750° C. (Fig. 4.)

(4) Calorimetric Methods.—Here also, as with the methods based upon the use of the air thermometer, it requires extreme care in order to guarantee the

FIG. 4.—Seyferth Thalpotasimeter.

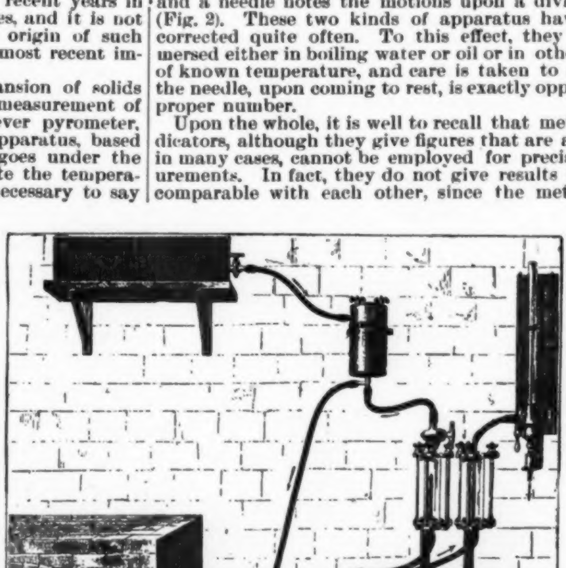


FIG. 5.—Pyrometer with Circulation of Water.

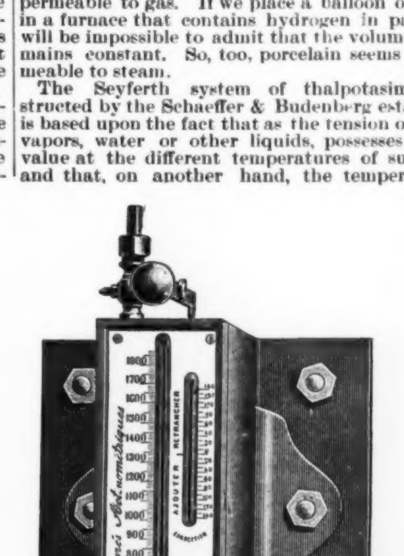


FIG. 6.—Latarche Actinometric Pyrometer.

measurements obtained. The general principles of these sorts of measurements may be enunciated as follows: A fragment of a body, of a weight, P, being raised to the temperature, T, to be determined, abandons upon cooling a quantity of heat proportional to the weight and to a function of the temperature previously known. Such quantity is determined by throwing the heated body into a calorimeter full of water, and in expressing that there is an equality between the number of heat units lost in the body and the number gained by the water.

But when the temperature rises, there intervene phenomena of vaporization and calefaction that render the measurements very delicate.

Pyrometers with copper or platinum balls are

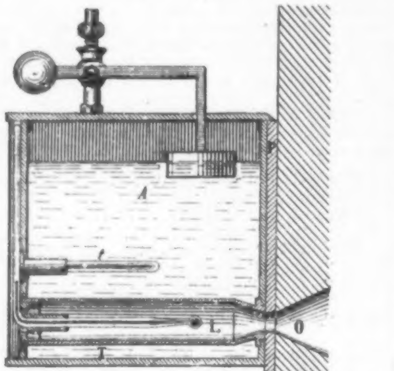


FIG. 7.—Installation of a Latarche Pyrometer.

based upon this principle. Losses of heat through radiation are prevented to as great an extent as possible by inclosing the ball in a jacket during the time that it remains in the furnace up to the moment in which it is allowed to fall into the calorimeter. Nevertheless, there is still a loss of heat during this passage.

Pyrometers in which there is a circulation of water, the invention of which is due to Mr. F. De Saintignon, are based upon the following principle: A metal tube is traversed by a current of water with sufficient velocity to prevent vaporization. The difference of temperatures of the water at the entrance and exit is a function of the temperature of the heat source, so that the apparatus is capable of noting with great accuracy the progress of the heating of a furnace, which to this effect is provided with the Richard differential registering apparatus consisting of two metal thermometers in which an expansion of a liquid occurs, and the indication of one of which continually curtails that of the other. This difference is inscribed by a style. The apparatus is arranged for temperatures of from 0 to 2,500° C. (Fig. 5.)

(5) A pyrometer giving quantitative readings is scarcely required in the industries. What is wanted before all else is a qualitative measurement—the possibility of fixing two limits between which it will be necessary to remain in order that the operation may proceed properly. From this point of view, the air thermometer, sufficiently simplified, reduced in fact to a metal tube and a pressure gage, gives through the readings of the latter the results sought.

The Latarche or actinometric pyrometer (Fig. 6) seems to us to be an instrument perfectly adapted to these qualitative measurements. It is a sort of opti-

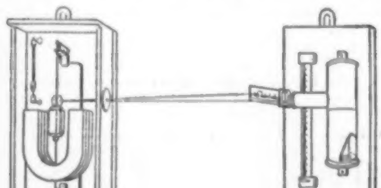


FIG. 8.—Galvanometer used with the Thermo-electric Pyrometer.

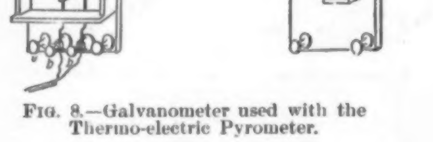


FIG. 9.—Mesuré & Nouel Pyrometric Spyglass.

cal thermometer, so to speak, which, fixed opposite the source of heat, determines the intensity of the latter.

In principle, the apparatus may, like the ordinary actinometer, consist of two thermometers—one of them an observation thermometer whose surface is covered with lampblack, and the other a silvered bulb. Exposed to the radiation of the heat source, these give two readings, which are so much the wider apart in proportion as the temperature ascends. In practice, these two thermometers are replaced by a single one, T, which is submitted on the one hand to the radiation through the funnel shaped aperture, O (Fig. 7), and on the other to the influence of a receptacle of a sensibly constant temperature taken for zero, which tends to bring it to the latter.

In brief, the apparatus consists of a receptacle, A, containing water which the waste heat of the furnace keeps in a state of ebullition. The thermometer, t, indicates the intervals above or below that permit of making corrections if the temperature is not 760°. The thermometer, T, is provided with a graduation upon which are seen the differences presented by the temperature of the furnace and the proper one.

Finally, the apparatus as a whole is fixed upon a foundation plate established against the masonry of the furnace, in which there has been formed an aperture, O. This pyrometer has given good results, but is as yet but little known.

(6) Methods based upon the Electric Resistance of Metals.—As well known, the electric resistance of metals is a function of the temperature of the form

$$Rt = Ro\,(1 + \alpha t + \beta t^2)$$

where α and β are numerical coefficients whose values are as follows:

Very pure metals	$\alpha = 0.003824$	$\beta = 0.00000137$
Mercury	$\alpha = 0.0007485$	$\beta = 0.000000398$
Platinum	$\alpha = 0.003669$	$\beta = 0.00000126$

In the Siemens electric pyrometer, an electric current traverses a platinum wire wound around a clay cylinder, which, placed at the point whose temperature it is desired to determine, is protected from contact with the gas of the furnace by an enameled porcelain tube of the ordinary temperature. The resistance of the wire is balanced by a known resistance. When the resistance increases with the temperature, a Wheatstone bridge permits of estimating the variations. It appears that it is thus possible to obtain an approximation of $\frac{1}{10}$ of a degree for 1,000° C.

(7) Thermo-electric Pyrometers.—These are based upon the measurement of the current produced when the soldering point or point of contact of two wires is heated. Thermo-electric batteries have been employed for a long time for the study of radiating heat (Melloni apparatus), for researches upon the temperature of living beings (Becquerel apparatus), or upon the temperature of heated liquid globules (Boutan apparatus); but Mr. Le Chatelier is the first one who has found a solution adapted for industrial measurements. The Le Chatelier thermo-electric pyrometer consists of a couple formed of a platinum wire and a wire made of an alloy of platinum with about ten per cent. of rhodium. The galvanometer designed for measuring the current produced is the Deprez and D'Arsonval aperiodic one (Fig. 8). The deflections are observed by means of the Poggendorf reflector.

It is thus possible to measure very high temperatures, toward the vicinity of the melting point of platinum. Moreover, it takes the couple but five seconds to put itself in an equilibrium of temperature with the surroundings. The apparatus is easily graduated, and, on account of the high temperatures to which the metals of the couple are submitted, it is well to verify it from time to time.

This arrangement, which is good in a laboratory, may, as we have said, be also successfully employed in the industries.

(8) Optical Methods.—In many cases, high temperatures may be estimated by sight, according to the color emitted; but this method may be so modified as to render it very precise, as follows: A plate of quartz deflects the plane of the polarized light to a degree nearly inversely proportional to the square of the wave length. If an incandescent body be observed through the Mesuré and Nouel pyrometric spyglass, in which a plate of quartz is placed between two Nicol prisms, the color perceived may be brought to the same tint by giving the two prisms inclinations that vary with the wave length of the light, and, consequently, with the temperature of the body that emits the latter (Fig. 9). This apparatus is much employed in metallurgical operations. It is of small dimensions, and it requires but one reading to determine the temperature. It can be intrusted to the hands of a foreman or of a watchman.

The Le Chatelier optical pyrometer is based upon the use of the absolute measurement of luminous intensity. It was elaborated by Mr. Cornu and put in a practical form by Mr. Le Chatelier. The light emitted by an incandescent body is compared with that of the flame of a small kerosene lamp. As with the ordinary photometers, the apparatus is so regulated that the

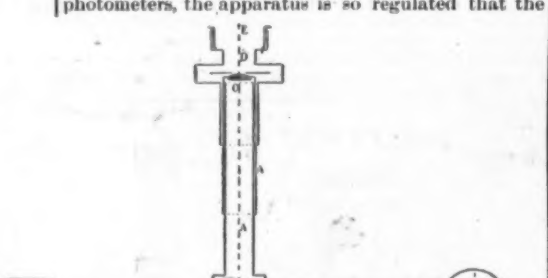


FIG. 10.—Le Chatelier Optical Pyrometer.

two images, intersected by the edge of the mirror, M, become juxtaposed (Fig. 10).

One difficulty of the application of the principle is due to the difference of the emissive power of the different bodies, which depends not only upon the temperature, but also upon their nature and the state of their surface. It must be added that such variation is so slight that industrial measurements are not affected thereby.

Mr. Le Chatelier has further indicated an indispensable condition to be fulfilled for the apparatus: The comparison should be directed toward the red radiations, which give a maximum of sensitiveness. A monochromatic red glass is therefore placed before the ocular, G.

In conclusion, we may say that metal pyrometers are capable of giving adequate readings in many cases, but that, when precise results (to within a few degrees) are needed, it is necessary to employ either the platinum resistance pyrometer or the thermo-electric one.—Le Genie Civil.

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